



Management of Poultry Breeding Stock in Southern Africa



Compiled by Alan Saunders

Foreword

The South African breeder industry has undergone some major changes since the early 1950's when the local commercial layer and broiler breeder industry consisted of many small privately owned businesses supplying day old chicks to the commercial farmer. Due to continual pursuit for improved efficiency, the number of breeders serving the poultry industry has gradually declined to the point where at present virtually the entire day old chick supply for the South African broiler industry is in the hands of three international breeding companies with franchise arrangements with local distributors. In the case of the layer industry, three international breeding companies supply the entire market requirement.

The aim of successful breeder management should be to ensure that the genetic potential in the production of day old chicks is achieved. This is only possible with high level of management and stockmanship using good and well maintained housing and equipment systems. A sound knowledge of the nutritional and environmental requirement of the stock and how best to manage the interaction between the bird and its environment, is a prerequisite for successful breeder management.

This book endeavours to supply details of housing conditions and equipment and general management techniques and bird health requirements that are considered to be essential for successful hatching egg production. It shares our experiences and knowledge of breeder management under Southern African conditions. It forms part of a series of books on poultry management and housing which are available from the address below.

The text should be read in conjunction with many broiler manuals available for specific breeds as well as equipment manuals specific to such equipment. This book is a guide to methods of housing and managing broilers commercially and contains written text as well as photographic illustration. I am indebted to many equipment supply companies as well as day old chick supply companies and breeders who serve the local broiler producer and who have assisted in supplying photos for this book.

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Disclaimer

The author has made every effort to ensure the accuracy of the information herein. Appropriate information sources should be consulted, especially for new or unfamiliar procedures. The author cannot be held responsible for any typographical or other errors found in this application. Neither is any liability assumed for damages resulting from the use of information contained herein.

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1 Breeder Housing and Equipment

Modern breeder housing should create an environment in which the bird has the ability to express its full genetic potential. With minimum environmental control, which is less costly to establish, the basic needs of the bird should be catered for. In more sophisticated production systems, control of the environment will be achieved more easily but the cost of establishing and maintaining such systems should be weighed up against the improved production efficiencies.

Breeding stock is normally reared in separate rearing houses specially designed for the purpose of rearing birds from day old to point of lay. These rearing facilities should preferably be light controlled (generally referred to as dark houses), especially in the case of broiler breeding stock. In these dark houses the light program may be controlled more effectively and the seasonal effect on sexual maturity and production performance is largely eliminated.

Whatever the housing or production system used, production efficiency and low cost production should not compromise the production of quality hatching eggs. Quality chicks can only be produced from hatching eggs that are of high quality. The welfare of the birds should also not be compromised.

1.1 Farm Planning

The size of the farm and individual houses will depend on whether they are part of a larger integrated breeder operation or whether a smaller independent hatching egg supply is intended. The larger the overall operation, the larger the farm and individual house size can be planned for, since the larger supply requirement will cater for the larger fluctuation in hatching egg supply as the individual sheds or sites are depopulated and restocked with birds.

Breeder operations also need to cater for separated rearing and breeding facilities since the buildings can then be designed for the specific purpose for which they are required.

Supply requirements of feed, water, chicks, etc. need to be planned for as well.

1.1.1 Key Planning Points

Whatever the size of the operation the size of individual sheds and sites need to be such that they are depopulated and re-stocked on an all-in, all-out basis. This is to ensure that the shed can be completely cleaned, the necessary maintenance after the long cycle carried out and the facilities disinfected and prepared prior to placement of the next cycle of birds.

The size of individual sheds would depend on the overall size of the operation. In the case of a smaller, independent operation, shed size would tend to be smaller as this will result in less fluctuation in overall production when individual houses are depopulated and re-stocked.

If the farm is part of a larger integrated business, the size of the individual houses will be larger as the hatching egg requirement would tend to be larger and fluctuation caused by the cycling of individual sheds would be less. Such operations may be of such a size

that multiple houses are placed on the same site. The houses are then stocked individually over a short period (two to three weeks) or simultaneously if the size of the operation makes this possible. In hatching egg production the principle of all-in, all-out replacement of the facilities should never be compromised.

As a general rule, most breeding stock will be transferred from rearing to breeding at 17 to 18 weeks of age in the case of layer breeders and 20 to 21 weeks of age in the case of broiler breeders. Layer breeders would normally be depopulated between 65 and 70 weeks of age while broiler breeders are normally depopulated at between 62 and 65 weeks of age. At these ages the decline in egg production, hatching egg quality as well as fertility does not warrant keeping the birds any longer.

With separated rearing and breeding facilities in the ideal planning situation, one rearing house or site would normally supply two breeding houses or sites.

For example if the breeder rearing house is depopulated at 21 weeks of age and if a 4 week period for cleanout and disinfecting and preparation for the subsequent flock is allowed, the total rearing house cycle would be 25 weeks. If the breeders are depopulated at 66 weeks of age, with a 5 week period between depopulation and restocking (for cleaning, disinfecting and preparation) the breeder house cycle is 50 weeks or twice that of the rearing house cycle. One rearing house would therefore supply two breeder houses.

Some other key issues would include:

- The premises should be fenced off and the enclosed area kept clean and grass kept cut.
- The premises should be well drained to ensure that rain water runoff is adequate.
- The premises and poultry buildings should be easily accessible for heavy vehicles
- Personnel and visitor access to the farm must be strictly controlled, preferably through showering and wearing of onsite clothing and foot ware
- Arrangements need to be made for adequate disposal of mortality. This could be through decomposition pits, composting of mortality or use of an incinerator.
- Mortality decomposition pits should not be flooded with water through seepage or rain water flowing into the pit. Enzymes are available which are used to assist in the decomposing process and elimination of odours. In the end bone material is all that should remain in the pit. When full the concrete slab and dome could then be moved over another pit, covering the original pit with soil. These mortality pit covers allow for carcasses to be disposed of quickly, simply and hygienically. The cover should be placed on a concrete slab over the pit and the translucent fibreglass dome incorporates a fly trap/air vent, observation window and flap for inserting carcasses. Environmental consideration is however resulting in these pits no longer being favoured.
- End of lay hen buyers should never be allowed access to the farm unless the farm as a whole will be depopulated, cleaned and disinfected before re-stocking with birds.

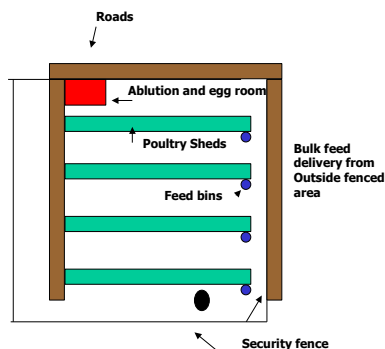
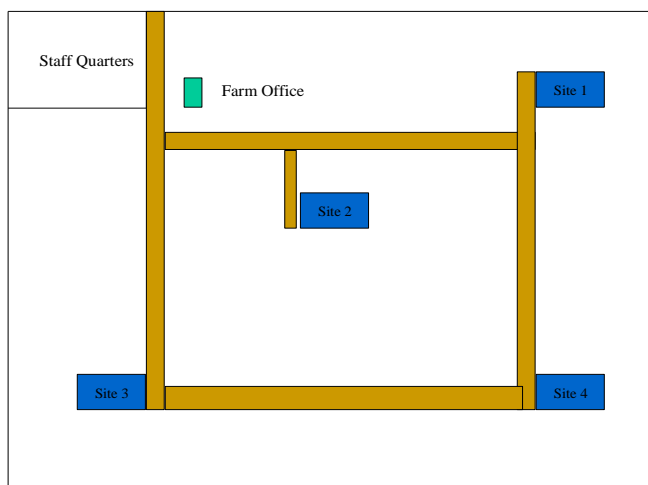
1.1.2 Farm Layout

Farm layout should be such that poultry sheds are well separated from one another (1.5 to 2.0 times the width of buildings) if two or more houses are placed on the same site. The length of the building should preferably be placed east to west (to reduce heat load through the sun shining on the walls) taking into consideration prevailing wind direction, especially in the case of natural ventilated houses.

The houses should also be spaced in such a manner that equipment and vehicles have easy access to the sheds. Heavy vehicle traffic in the form of feed trucks should be accommodated in all weather conditions.

A number of sites may be placed on larger farms with the sites well separated from one another. The distance between sites remains debatable but in general a minimum distance of 700 to 1000 meter is considered sufficient. The site should be separate units with no direct contact between them.

Typical layout of a multiple site breeder farm and a breeder site are shown below.



1.2 Environmental Control

Heat within the building originates from heat generated by the birds as well as heat entering the building through the roof and walls. During conditions where environmental temperature exceeds the temperature requirement of the birds, management of the environment must ensure that the heat generated in the building is removed. This is achieved by ventilation and in areas of extreme heat evaporative cooling systems are used as well,

During conditions where environmental temperatures are low, heat produced by the birds should be preserved and used to maintain house temperatures within the temperature comfort limits of the stock involved. During the first three to four weeks, supplementary heat is to be provided as chicks are unable to maintain body temperature. With adult stock, especially when the house is reasonably insulated, the heat generated by the birds will assist to maintain house temperature close to the required norm. Under these conditions, a minimum amount of ventilation should be applied to ensure sufficient removal of moisture and metabolic gases such as ammonia and carbon dioxide and to ensure sufficient supply of oxygen. When the building is poorly insulated, heat loss will be excessive and desired temperature will not be maintained under low outside temperature conditions.

1.2.1 Temperature Requirement

The Environmental Temperature within the building should preferably be maintained within the ranges as suggested in Table 1.1. At temperature conditions within these norms, the birds will be able to maintain body temperature without having to apply mechanisms to increase heat loss or body heat production when temperatures are above or below the norm. This is commonly referred to as the thermo neutral temperature zone of the birds. During the first three to four weeks this is of special importance as chicks are unable to adjust metabolic processes to maintain body temperature. Body temperature of chicks will soon increase or decrease if environmental temperature is outside of these ranges.

Table 1.1: Brooding and House Temperature Requirement

| Age | Whole house brooding (°C) | Spot Brooding 2 m from Brooder (°C) |
|---------------|---------------------------------|---|
| Day old | 30 to 32 | 32 to 34 |
| 2 days | 29 to 31 | 31 to 32 |
| 3 to 7 days | 27 to 29 | 28 to 30 |
| 8 to 14 days | 24 to 26 | 26 to 28 |
| 15 to 21 days | 20 to 25 | - |
| Adult | 20 to 25 | - |

In growing birds and adults, production performance and feed intake will be affected if the environmental temperature is below and above the ideal range, especially when such temperature prevails for a long period of time.

1.2.1.1 Effect of Low Temperature

For the first two to three weeks, chicks have difficulty controlling body temperature and during the first couple of days in fact react similarly to cold blooded animals. They just become colder and cannot adjust body temperature. Conditions that ensure cloacae temperature of 40 to 40.8°C are essential in avoiding chilling of chicks. A large percentage of starve outs (non-starters) will be seen in a flock in which the chicks have been chilled. Smaller chicks originating from young parent stock are even more susceptible to cold stress.

In adult stock, temperature below the ideal will result in increased metabolic activity which is aimed at maintaining body temperature. In layer breeders this will result in increased feed intake with a consequent deterioration in feed efficiency as the birds are fed *ad libitum*.



Example of chilled chicks huddling and inactive on left and warm chicks evenly spread out and active on right

In broiler breeders low temperature may require adjustment to the feed allocation to compensate for the increased metabolic activity to maintain body temperature. With fluctuating winter temperatures within a short period of 24 hours, especially so in open sided house where it may be difficult to maintain the inside house temperature, it is difficult to accurately judge and anticipate the required feed to be allocated to broiler breeders.

The effect of low temperatures on feed intake requirement would therefore not only depend on the extent of the reduction in temperature but also on the time involved.

1.2.1.2 Effect of High Temperature

When chicks are subjected to high temperatures, it will soon result in heat stress as they are unable to adjust metabolic rate in order to maintain body temperature. They will become lethargic and dehydrated resulting in reduced feed intake, consequent reduction

in growth rate, increased starve-outs and mortality. For the first two to three weeks, temperature has to be maintained within very narrow limits.

At temperatures above the thermo neutral zone, mechanisms are brought into effect to rid the bird of increased body heat. The need for increased body heat loss through sensible heat loss increases. Higher temperature would therefore call for higher rates of ventilation for the birds to dispose of the increased heat load through convection (air movement over especially face, comb and wattle surfaces). Should temperature increase even further, heat loss through evaporation of moisture from the epithelial of the respiratory tract (latent heat loss through panting) increases and under these conditions the supply of fresh cool water as well as adequate ventilation are important. Mature birds are therefore able to compensate to some degree to environmental temperatures above the norm, but this does have consequences.

At high environmental temperature, the use of lipids (fat) as energy source holds advantages as the heat production in digesting and metabolizing fat (heat increment) is lower than that of carbohydrates. The bird will have fewer problems in maintaining normal body temperature.

A further consequence of high temperatures in breeding birds in lay is that high environmental temperatures have a depressing effect on shell quality. At temperatures above 35°C shell thickness becomes significantly poorer, this effect is noticeable at the point when birds begin to pant (28 to 30°C).

Even though it is common practice to offset lower feed consumption by feeding higher concentrations of calcium (also in a more coarse form) during summer, eggshell thickness will generally decrease during periods of high environmental temperature. The reason for this is that panting reduces the ability of blood to transport calcium that is needed for eggshell formation. This is due to blood acid/base imbalances resulting from the continued process of panting. The use of sodium bicarbonate to replace part of the normal salt in the ration has been proven to reduce this problem. None the less poor shell quality, especially in older flocks, remains a major problem in conditions where house temperature cannot be maintained below 30°C during summer.

1.2.2 Moisture Content of Air

Control of the moisture content of the air within poultry buildings is important because it affects litter quality and overall environmental conditions within the poultry shed. Breeder birds are kept in the buildings for long periods and once litter has been allowed to become wet and caked the tendency for high ammonia levels will increase.

1.2.2.1 Moisture Production

Moisture production in a poultry houses is influenced by various factors including:-

- Excessive levels of dietary salt causes increased water intake and increased kidney activity to remove the sodium from the body, resulting in wet litter conditions
- Increased energy content of the diet increases water consumption and results in faeces with higher moisture content

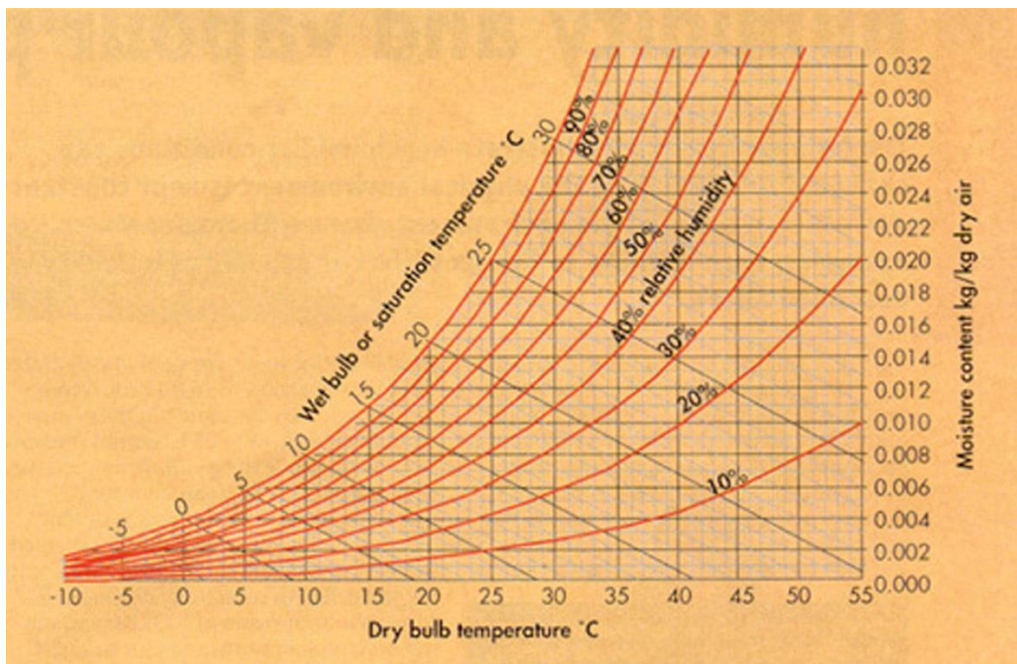
- Pelleted feed produces droppings with higher water content compared to mash feed
- Impurities in water could result in increased activity of the kidneys to rid the body of such impurities
- High environmental temperature increases water consumption
- Feed restriction in broiler breeders results in increased water intake and with open drinkers this becomes an even greater problem.

1.2.2.2 Effect of House Temperature on Relative Humidity

Hot air can hold more moisture than cold air and the water produced by the birds can be taken up more readily by warm air in the building. Insulating poultry sheds will therefore indirectly influence the moisture content and litter conditions within the building. Maintaining the inside temperature at higher levels during winter will assist in keeping the shed not only warmer but also drier.

It is important to understand the concepts of psychrometric science to get to grips with the concepts of controlling the moisture content of the environment. These concepts are used to illustrate the relationship between dry bulb temperature, wet bulb temperature, relative humidity and moisture and heat content of air. By viewing a psychrometric chart more closely (Figure 1.1) it will be seen that at 15°C, 65% relative humidity (RH) and a wet bulb temperature of $\pm 12^\circ\text{C}$, the air contains approximately 7g of water per kg dry air. If the air temperature is increased to $\pm 22^\circ\text{C}$ at the same amount of moisture (7g/kg), the RH drops to close to 40%. In order to get back to 70% RH the water content of the air has to increase to 12g/kg dry air (almost double). The warmer air is therefore able to "hold" more moisture at the same RH. Cold house temperatures will therefore not be conducive to absorption of moisture from the litter, creating wet and unpleasant conditions in the building.

Figure 1.1: A Normal Psychrometric Chart



1.2.2.3 Psychrometrics of Air

The Psychrometric Chart can be used to explain the psychometrics of air. It illustrates the relationship of dry bulb temperature, wet bulb temperature, relative humidity and specific humidity.

The **specific humidity** differs from the RH of the air in that it is the amount of water vapour, by weight, in the air. Specific humidity, represented as vertical lines on the chart is normally given in gram (g) of moisture per kilogram (kg) of air and read on right hand scale of the diagram.

The **dry bulb temperature** of the air is the air temperature determined by an ordinary thermometer. On the psychrometric chart the dry bulb temperature scale is located on the bottom horizontal line. The vertical lines on the diagram indicate the same dry bulb temperature.

In managing breeders during rearing as well as during the laying period, it is essential to record the daily house dry-bulb temperature as well as the outside environmental dry-bulb temperature in the shade. Thermometers which record the maximum as well as the minimum temperature within the period of the instrument being "zeroed" are ideal. In the shed, the thermometer should be suspended at the probe controlling the ventilation in fan ventilated houses. In open type houses it is equally important to record house dry bulb temperature on a daily basis as this will provide information on the success of adjusting the curtains (air inlets) and the ability to maintain temperature within the temperature comfort zone of the birds.

Two or three thermometers placed at various points will provide information on temperature differences within the building.

The wet bulb temperature would provide indication of the extent to which water is evaporating to the environment. Wet bulb temperature can be determined by passing air over a thermometer that has been wrapped with a small piece of moist cloth. The cooling effect of the evaporating water causes a lower temperature compared to the dry bulb air temperature. In the psychrometric chart the wet bulb temperature scale is located along the top most curved line and the diagonally sloping lines from the upper left-hand side to the bottom and the right hand side of the chart indicate equal wet bulb temperatures.

Wet bulb temperature can never be higher than dry bulb temperature and if equal to dry bulb temperature, the air is saturated with moisture. The point of 100% saturation is the dew point temperature scale.

Relative humidity is a measure of how much moisture is present in the air compared to how much moisture the air could hold at the specific dry bulb temperature. Relative humidity is expressed as a percentage (%) value. Lines presenting conditions of equal relative humidity sweep from the lower left to the upper right of the psychrometric chart. The 100% relative humidity (saturation) line corresponds to the wet bulb scale line. At this point the dry and wet bulb temperatures are the same. The line for zero percent

relative humidity (air contains no moisture at all) falls along the dry bulb temperature scale line.

Thermometers with a dry bulb as well as wet bulb readings are available from which the RH may be read directly. Electronic thermometers that measure these traits in the air are also available. Whilst adult birds will be able to cope with a wide range in relative humidity, very low levels (<20%) as well as very high levels (>80%) should be avoided. Humidity levels above 80%, especially at high temperature and poor ventilation is potentially dangerous as the birds will not be able to dispose of adequate amount of body heat through latent heat loss via the respiratory tract.



Dry and wet bulb thermometer top left an electronic thermometer right and a maximum/minimum thermometer bottom left used for monitoring poultry house conditions

Low humidity levels will tend to create very dry and dusty conditions, which will adversely affect the respiratory tract, especially when respiratory disorders are present. For chick rearing relative humidity levels in the order of 50 to 65 % is recommended.

1.2.2.4 House Temperature and Litter Quality

Excessive wet litter in poultry houses is conducive to high levels of ammonia which is not only harmful as such but which will exacerbate any respiratory disease. Breeder house litter consists of undigested biodegradable materials as well as bedding material used. Under normal conditions decomposition will occur and depending on the humidity and density of the litter, the decomposition could be anaerobic or aerobic.

Anaerobic decomposition of litter

Anaerobic (oxygen deficient) decomposition of litter is to be avoided as the by-products from this form of decomposition include harmful gases such as ammonia and methane. This form of decomposition is more prevalent when the litter is compact and wet.

Aerobic decomposition of litter

This form of litter decomposition supports the growth of bacteria and other natural predators of fly larvae. By-products from this form of decomposition will include carbon dioxide, water and nitrates but not ammonia. This form of decomposition will be more prevalent under conditions where the litter is relatively dry and well aerated.

1.2.3 Gases in the Air

Several gases are found in poultry sheds, some of which are required at minimum levels (oxygen) and others which are by-products of the metabolic processes and which, at high concentrations, will result in reduced performance or even death. Under conditions of low ambient temperatures when the required rate of ventilation is minimal it is important to consider the possible build up of toxic metabolic gases or insufficient supply of oxygen.

Minimum and maximum tolerated gas composition of air is illustrated Table 1.2.

Table 1.2: Tolerance of Gasses in Air

| Gas | Outside air | Inside air |
|-----------------------------------|-------------|----------------|
| Oxygen (O ₂) | 21% by vol | Min 15% by vol |
| Ammonia (NH ₃) | | 25 ppm |
| Carbon dioxide (CO ₂) | 300 ppm | 2500 ppm |
| Carbon monoxide (CO) | | 40 ppm |

Importance of Ammonia

Ammonia is produced as a by-product in the anaerobic decomposition of litter. The symptoms of extreme concentrations of ammonia are a nauseating smell to the caretaker and irritation of the eyes. Although adult stock may tolerate higher levels of ammonia as compared to for example broilers, high levels of this gas should be avoided.

Levels of ammonia should be less than 10 parts per million (ppm) by volume. Levels of 10 to 20 ppm will not be harmful, provided the period during which birds are exposed to these levels are short (for example a couple of hours during early morning). Above 20 ppm production efficiency will be affected, especially when birds are subjected to such concentrations for extended periods of time.

The minimum air exchange rate required should therefore not only supply sufficient levels of oxygen and remove sufficient levels of carbon dioxide from the building, but should also be sufficient to maintain dry manure conditions through the removal of sufficient amount of moisture from the building. Further control rests with the ability to keep the litter as dry as possible through elimination of water spillage. With broiler

breeders under feed restriction and open drinker systems it is often difficult to maintain dry litter.

1.2.4 Ventilation

Ventilation requirement in the poultry building is to supply oxygen, to remove metabolic gases and moisture at low temperature ranges (minimum ventilation) and to remove heat from the building at high temperature ranges intermediate and maximum ventilation).

1.2.4.1 Minimum Ventilation

Amount of minimum ventilation

Under normal conditions the minimum ventilation required that will ensure sufficient supply of oxygen and sufficient removal of carbon dioxide and moisture can be calculated by using the following formula suggested by Agriculture Development and Advisory Service (ADAS) in the United Kingdom:-

$$V \text{ min (m}^3\text{/sec/bird)} = (1.6 \times 10^{-4} \times \text{ALW}^{0.75})$$

ALW = average live weight in kg

By using this formula the minimum ventilation requirement for adult birds may be calculated as being:

- For layer breeders weighing 2.0 kg the minimum would be 0.48 m³/hour/kg or 0.97 m³/hour/bird
- For broiler breeders weighing 3.5 kg the minimum would be 0.42 m³/hour/kg or 1.47 m³/hour/bird

The same formula can be used for calculation the minimum ventilation rate required for growing breeding stock provided the weight for age is known. By using the weight for age, this data can be used to calculate the minimum ventilation requirement of growing birds from day old to point of lay. By doing this, much guesswork is taken out of knowing how to set the minimum ventilation. It should be noted that when using this formula the ventilation requirement expressed as cub meter per kg live weight is higher at the beginning compared to towards the end of the growing period. This is logical as the relative gain in weight during the initial stages (hence metabolic processes) is higher compared to towards the end. The above is applicable under normal conditions of temperature and humidity and should be applied irrespective of the extent to which the temperature is below the required range.

At high levels of humidity, especially when ambient temperature is close to the required norm within the building, note should be taken that this level of ventilation might not remove sufficient levels of moisture produced by the birds.

Supply of minimum ventilation

Minimum ventilation is supplied under conditions where temperatures are low. The minimum ventilation should therefore be introduced over the entire building as evenly as possible and directed away from the birds.

In mechanical ventilated buildings this is achieved by speed control of fans or step control where certain minimum fans are operated intermittently by a time clock.

When using conventional side inlets together with negative pressure fans, the inlets should be adjusted to such an extent that a negative pressure of around 30 Pascal is maintained to ensure that air speed at the inlets is in the region of around 300 m/min. These inlets should be small and evenly distributed throughout the building, directing air away from the birds.



Example of side inlets and a fan jet to supply minimum ventilation

A plastic tube with holes (commonly referred to as a fan jet) with a positive pressure fan and air intake system from outside (louver) is often used to distribute fresh air as well as circulate and mix air within the building when the fresh air intake is closed. The louver opens on a timer system calculated on the fresh air requirement and a negative pressure exhaust fan extracts stale air when the louver opens. The system is often used to distribute hot air from a heat exchanger. The system has the negative of being difficult to clean, especially in floor systems but they do function very well in the distribution of cold fresh air throughout the building.

In open sided buildings the stack effect of ventilation is used to achieve a minimum rate of air movement. Hot air will rise and is replaced by colder air moving in (also called the chimney effect). This is achieved by having a ridge opening in the roof and by opening and closing side wall curtains or openings, the extent to which the building is being ventilated can be controlled to some extent. The stack effect is very appropriate in double storied buildings commonly referred to as high rise buildings. These buildings are relatively high and this assists in achieving a good chimney effect.

In buildings with no roof ridge the extent of minimum ventilation can only be controlled by opening the sidewall curtains or opening using normal wind pressure to achieve the required rate. The extent of controlling the amount of ventilation is however limited.

1.2.4.2 Maximum Ventilation

Once temperature exceeds the required temperature within the building, an increasing amount of ventilation needs to be applied to remove the heat from the building to prevent excessive heat build up.

The maximum ventilation rate required is therefore based on the highest expected body mass in the building (heat produced by the birds) as well the location (outside environmental temperature) and amount of insulation (heat entering the building from outside).

Various formulae may be found in the literature by which the ventilation requirement of poultry stock may be calculated. Under conditions of reasonably well insulated buildings the suggested formula of the Agriculture Development and Advisory Service (ADAS) in the United Kingdom may be used for calculating the maximum ventilation under extreme hot conditions that would normally apply in South Africa:-

$$V \text{ max (m}^3\text{/sec/bird)} = (2.0 \times 10^{-3} \times \text{ALW}^{0.75})$$

ALW = average live weight in kg

Using this formula the maximum ventilation required for South African conditions where summer temperatures often exceed 30°C is calculated as being:

For **layer breeders** weighing 2.0 kg, it would be 6.0 m³/hour/kg or 12.0 m³/hour/bird.

For **broiler breeders** weighing 3.5 kg it would be 5.2 m³/hour/kg or 18.2 m³/hour/bird

For a layer breeder and broiler breeder rearing the 18 and 21 week old weight will be used to calculate the maximum ventilation required as these weights will be the maximum that will apply.

Cognisance must be taken that in the case of breeder flocks the males are heavier.

In mechanical ventilated buildings this maximum ventilation requirement will be achieved by the installation of sufficient number of fans and inlets.

In open sided buildings ventilation is achieved by control of side inlets and allowing the wind pressure effect to ventilate the building. There is obviously much less control in the ventilation of open sided buildings.

1.2.4.3 Intermediate or Transitional Ventilation

Between the required minimum and maximum ventilation, varying rates of ventilation would be applied in order to find a balance between the amount of heat generated (by the birds and heat load from outside) and the heat being removed in order to establish the desired temperature conditions inside the building.

In mechanical ventilated buildings, the amount of intermediate ventilation is obtained by means of a step control system or variable speed fans. By step control the fans will be controlled by a thermostat, which will operate increasing numbers of fans from the minimum rate, in steps, until all fans are operating at maximum ventilation. Air inlets will open and close as the ventilation requirement increases or decreases.

With single-phase fans speed control is possible and fans are then operated at variable speeds to obtain the desired rate of ventilation between the minimum and maximum rates.

In open sided buildings intermediate ventilation is achieved by opening or closing the side curtains to a larger or lesser degree, depending on the amount of ventilation required.

1.2.5 Cooling Breeder Houses

In relatively dry climates cooling of air through evaporation of water (adiabatic cooling) is an inexpensive yet effective way to reduce temperature in poultry sheds. Effective cooling systems should be able to reduce the air temperature to within 85% of the difference between dry and wet bulb temperature.

The systems have limited use in areas where the relative humidity is high during high temperature conditions. The evaporation of water increases the relative humidity even higher and conditions may be reached where the relative humidity reaches high and dangerous levels. At high temperature and relative humidity, birds are unable to dispose of body heat through latent heat loss (evaporation of moisture from the respiratory tract) as the air already contains high levels of water vapour.

Various systems are available in which evaporation of water is used to reduce temperatures in poultry sheds and they consist mainly of wet pad systems and high pressure fogging systems

1.2.5.1 High Pressure Fogging

In high pressure fogging systems water is turned into a fine mist through a high pressure pump and nozzle system and the fine mist is sprayed into the building which is then able to absorb heat (convert sensible heat into latent heat) thereby reducing the dry bulb temperature (sensible heat).



Example of High Pressure fogging

These systems are especially popular in open sided houses as no forced ventilation is required for effective use. Dripping nozzles should be avoided as much as possible as this could lead to wet conditions on the floor as well as manure. The effectiveness of fogging systems can be increased when used in conjunction with air circulating fans within the building to increase air velocity over the birds.

1.2.5.2 Cool Pads

In these systems air is drawn through wet perforated pads where the water is allowed to evaporate. This system is therefore used in negative pressure ventilated sheds.

Water is pumped from a sump into a trough above the pad from where it flows through the pad. Surplus water is returned to the sump via a trough situated at the bottom of the pad. The water which evaporates into the air is replenished by fresh water supply into the sump.

An air speed through the pad of 70 to 100 m/min is generally recommended for adequate cooling.



Example of Cool Pad Systems

1.2.5.3 Wind Chill

Under conditions of high environmental temperature it is advantageous to use the wind chill factor of air moving over the birds to assist in maintaining a more comfortable sensible heat even though the house temperature remains relatively high. The effect of air moving over birds and the effect on the sensible heat felt by the birds at an environmental temperature of 30°C is illustrated Table 1.3.

Table 1.3: Effect of Airspeed on Sensible Heat of Poultry at temperature of 30°C

| Air Speed (m/sec) | 1 week old °C | 4 weeks old °C | Adult birds °C |
|----------------------|------------------|-------------------|-------------------|
| 0.5 | -2.2 | -1.1 | -0.5 |
| 1.0 | -6.6 | -3.8 | -2.2 |
| 1.5 | -12.2 | -7.7 | -4.4 |
| 2.0 | | -11.1 | -12.7 |

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The age of the stock and temperature conditions should however be considered. Young stock and chicks especially are very susceptible to wind chill and should never be subjected to high air velocity. At colder temperatures the wind chill effect would be higher and the closer the environmental temperature is to body temperature the lower the effect.

When temperature is close to the comfort zone the air speed over adult stock should be between 0.5 and 1 m/sec. Under high temperature conditions (>30°C), the air speed should exceed 1 m/sec to a maximum in the order of 2 to 2.5 m/sec. With low temperature, air movement over adult birds should be kept to the minimum (<0.5m/sec).

Note that this is the air speed over the birds and not the air speed at the inlets.

In open sided buildings wind chill is achieved by installing air circulating fans down the length of the building, spaced 20 to 25 meters apart to circulate the air over the birds.



Example of air circulating fans to increase wind chill in open sided buildings

In fan ventilated buildings the use of tunnel ventilation (also referred to as longitudinal ventilation) by installing fans at one gable end and the air inlets at the opposite gable end and moving the air down the length of the building will result in good air flow over the birds. With cross ventilation buildings the air moves over a larger area and the air velocity is low and wind chill therefore has very little effect in cross ventilated buildings.



Example of a tunnel ventilated building

1.3 Open Sided Houses

Natural ventilated or open sided houses are buildings where the amount of air entering the building through natural forces is controlled by the opening and closing of side air inlets. These natural forces are through Stack Effect and Air Pressure Effect. The stack effect of air movement is the upward movement of warm air being replaced by colder air at the bottom and in open sided houses this is used to control conditions under minimum ventilation. With air pressure effect wind pressure is used to create cross ventilation in the building by the control of side curtains.

Open sided buildings are popular in South Africa for the keeping of adult breeding stock as they are relatively easy and less costly to construct, simple to manage and the operating costs are low due to low electrical power required and low maintenance costs.

Compared to closed houses these savings should however be weighed up against the poorer control of environmental conditions and the effect on performance. Especially in the case of broiler breeders, less fluctuation in the environmental temperature in closed houses would provide for improved control on feed allocation.



Example of open sided without and with roof ridge openings

With open sided houses the side inlets should be easily adjusted to suite the ventilation requirement and special attention should be given to ensure that a minimum amount of ventilation through the stack effect is achieved. This is normally achieved by constructing an open ridge in the roof and by control of the side inlets, the amount of air that moves upwards and out through the ridge is controlled by the amount of fresh air allowed to enter through the side inlets.

When conditions require for increased ventilation, the side curtains are opened more to allow for cross ventilation.

In these houses the roof area should preferably be insulated to reduce the amount of heat entering the building from outside and in rearing houses to limit the heat loss during brooding.

1.4 Closed Houses

Closed houses are buildings in which the amount of air entering the building is controlled by mechanical means. Fans and inlets are used to control the amount of ventilation required.

These houses are less popular in South Africa for keeping of breeding stock as they are costly to construct, require electrical standby power and have higher maintenance costs compared to open sided buildings. Fan ventilated buildings will however provide for better control of environmental conditions, especially in very hot climates and where the ventilation system is linked to an evaporative cooling system. Especially in the case of broiler breeders, less fluctuation in the environmental temperature in closed houses would provide for improved control on feed allocation.



Fan ventilated house and light trapping cassette on fans

In fan ventilated buildings better control on the lighting program would be possible, as the natural seasonal changes in day length is eliminated, provided the inlets and fans are light trapped. For this reason, closed houses would be preferred for rearing of breeding stock.

1.5 Heating Systems for Breeder Rearing Houses

The normal body temperature of the day old chick is in the order of 41°C but this is only reached at 10 days of age, provided that it is kept under ideal environmental conditions. If subjected to low environmental temperature during the first 20 days of its life, the chick is unable to produce sufficient heat through the normal metabolic processes to maintain body temperature for prolonged periods of time. During the first week of the chicken's life it needs access to an area where temperature is above 30°C , during the second week 27 to 28°C and during the third week 25 to 26°C . Thereafter the normal temperatures of 20 to 25°C should prevail.

The amount of heating required and the type of brooder will depend on the extent of insulation used and whether the building is naturally ventilated or closed and ventilated by artificial means.

1.5.1 Brooding Methods

Various brooding methods are applied to supply the correct environment and temperature for rearing chicks and depending on the type of brooding method, various types of heater equipment may be used to maintain the required temperature conditions.

The methods used in heating poultry buildings may be divided into two main categories.

1.5.1.1 Spot Brooding

With spot brooding the chicks are confined to a concentrated area which is heated. The temperature in this smaller brooding area is therefore more important than the temperature of the surrounding area within the building. This method is commonly used in open type buildings but could also be applied in closed houses.

1.5.1.2 Whole House or Partial House Brooding

In whole house brooding the entire house or confined area in the building is heated by distributing heated air into the entire building. Although chicks may still be confined to demarcated brooding enclosures, the temperature in the building becomes more important. Only a portion of the building may be used for brooding purposes to save in heating costs. This is then generally referred to as partial house brooding.

1.5.2 Heating Equipment

Various types of heaters are available by which chicken rearing houses are heated.

1.5.2.1 Heat Exchangers

Heat exchangers could use gas, electricity, oil burners or coal burners as source of heat and are used to heat an entire building or part of the building. Air is passed through the heat exchanger before being blown into the poultry shed. The heated air is often distributed via a duct or plastic tube (fan jet) with holes down the length of the building and the air from within the building is then circulated back to the heat exchanger. The fan jet could also be coupled to the minimum ventilation system to distribute the minimum air required as evenly as possible. In the absence of a fan jet, air circulating fans could be used to assist in distributing the air throughout the building.

Various sizes of heat exchangers are available to suite smaller and larger house conditions.



1.5.2.2 Open Flame heater

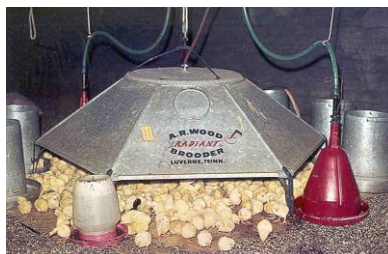
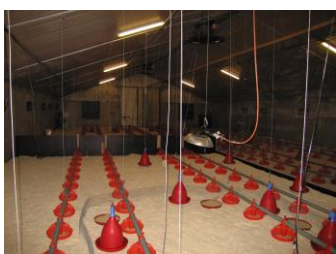
Open flame heaters which are usually gas or oil fired, could also be used together with air circulating fans to heat the entire building or confined areas in partial house brooding.



1.5.2.3 Canopy Brooders

Canopy brooders consist of small steel canopies fitted with a gas fired heater element or and electrical heater element and thermostat control. The heater is suspended about 1 to 1.5 meters above the chicks and the chicks would be confined to a brooding area around the brooder, especially in open sided houses.

Infrared gas brooders use a special burner under a tile reflector that produces infrared rays when heated and has a small canopy. The chicks are confined to a specific area with this type of brooder and the infrared rays heat the floor area. With these heaters the temperature of the object being heated (chicks and floor) is more important that the temperature of the surrounding air, although the latter will eventually be heated through convection from the heated objects.



These brooders are available in various sizes (1000 to 5000 chicks per brooder) and manufacturer recommendations and application should be used.

1.6 Feeding Systems

Feed remains to single most costly item in poultry production and the equipment must ensure proper supply without feed wastage.

1.6.1 Feeding Space

The feeding space required would normally be provided by breeder companies of the stock involved. As a general rule the feeder space for layer and broiler breeders presented in Table 1.4 can be used.

Table 1.4: Feed space guide for breeders

| Application | Unit | Space |
|--|------------------|-----------|
| <u>Broiler Breeders</u> | | |
| Chick feeders (φ35 cm) | Chicks/feeder | 100 – 150 |
| Day old to 6 weeks (φ 35 cm) | Birds/feeder | 20 – 22 |
| Day old to 6 weeks (Trough) | cm/bird | 7 - 8 |
| 7 to 20 weeks (φ 35 cm) | Birds/feeder | 10 – 13 |
| 7 to 20 weeks (Trough) | cm/bird | 13 - 15 |
| Laying period (φ 35 cm) | Birds/feeder | 14 – 16 |
| Laying period (Trough) | cm/bird | 14 – 16 |
| Male feeders (φ 35 cm) | Males/feeder | 10 – 12 |
| <u>Layer Breeders and Pullet Rearing on Floor</u> | | |
| Chick feeders (φ35 cm) | Chicks/feeder | 100 – 150 |
| Day old to 6 weeks (φ 35 cm) | Birds/feeder | 50 – 60 |
| Day old to 6 weeks (Trough) | Birds/meter | 5 - 6 |
| 7 to 20 weeks (φ 35 cm) | Birds per feeder | 30 – 40 |
| 7 to 20 weeks (Trough) | Chicks/feeder | 9 - 11 |
| Laying period (φ 35 cm) | Birds/feeder | 20 – 30 |
| Laying period (Trough) | cm/bird | 10 – 12 |

In broiler breeder rearing as well as during lay the feed space requirement is critical as birds are subjected to feed restriction and all birds should be able to feed simultaneously.

1.6.2 Chick Feeders

These feeders consist of flat containers with a 2.5-cm edge, usually made of plastic. Feed is placed in the container and chicks will jump into the container and feed. Such feeders are removed as soon as the birds are able to feed from the larger feeders. These feeders are concentrated in the brooder area. Feed may also be scattered on paper in the brooding area.



Example of preparing feeders and drinkers for chicks

1.6.3 Manual Feeders

In floor operations hand feeders may consist of open, long troughs into which feed is placed from which the birds may then feed. Tube feeders are also used which consists of a tube 20 to 40 cm in diameter and 400 to 500 cm high to which an adjustable pan is fitted at the bottom. The gap between the tube and the pan is adjustable so as to set the amount of feed that will flow from the tube and therefore the level of feed in the pan. The

advantage of hand filled tube feeders compared to hand filled trough feeders is that the tube serves as a reservoir for feed, requiring feed to be replenished less often.



Example of manual feeding in floor rearing

1.6.4 Automated Feeders

Automated floor feeders consist of many types and makes and the more popular feeders can be classified into chain feeders and pan and auger feeder.

The choice of feeding system would depend on personal preference. With broiler breeders especially where controlled feeding is to be applied, the feeder should distribute the feed to all birds within 2 to 3 minutes and feeder space should be sufficient to allow all birds to feed simultaneously.

1.6.4.1 Chain Feeders

Chain feeders consist of a continuous open trough around the shed fitted with a flat chain which drags feed from a central hopper which acts as a reservoir of feed. The central hopper is filled by an auger, which conveys feed from a bulk feed bin. The hopper is also fitted with high and low sensors, which will cause the auger motor to switch off and on as required. The motor, which drives the chain in the trough, is in turn controlled by a time clock. This enables automated and controlled setting on the amount of feedings required in the case of *ad libitum* feeding. Single, double, as well as three track feeders are available to allow for increased feed space as required. Slow and high-speed feeders allow for various conditions such as feeding young chicks or birds being subjected to control feeding. The entire system can be suspended from the building by cables and a winching system if crossbeams are able to carry the weight or the troughs may be fitted to carrier legs, which allows for height adjustment.



Example of chain feeding systems for floor operations

Although chain feeding systems are easy to manage and are generally less costly they have the disadvantage that the house is divided into sections. In long houses care should be taken to ensure that feed is distributed within 2 to 3 minutes when controlled feeding is applied. The feeder hopper may be placed in a centre service bay and a dummy hopper at the end of the feed chain, which is manually filled, may be incorporated to reduce feeding time.



Dummy hopper fitted to a chain feeder to improve feed distribution

1.6.4.2 Pan Feeders

Pan feeders consist of a tube (or other form of feed conveyor) in which an auger conveys feed from one end to which a feed hopper has been fitted. Openings made at the bottom of the tube then allow feed to drop from the tube to a pan fitted to the tube. The gap between the pan and tube is adjustable so as to set the amount of feed deposited into the pan. The pans are therefore filled from the hopper end as feed is conveyed down the length of the tube. A limit switch is fitted to the last pan on the tube. This switches the drive motor on and off, depending on the height of feed in the last pan. An auger from the bulk feed bin fills the hopper and the amount of feed in the hopper is controlled by high and low limit switches.

The required feeder space is achieved by increasing the number of pans fitted to the tube or increasing the amount of feeder lines (tubes) in the shed. The system is suspended

from the ceiling on cables and a winching system so as to allow for adjustment of feeder height as well as lifting the feeder system out of the way for cleaning.



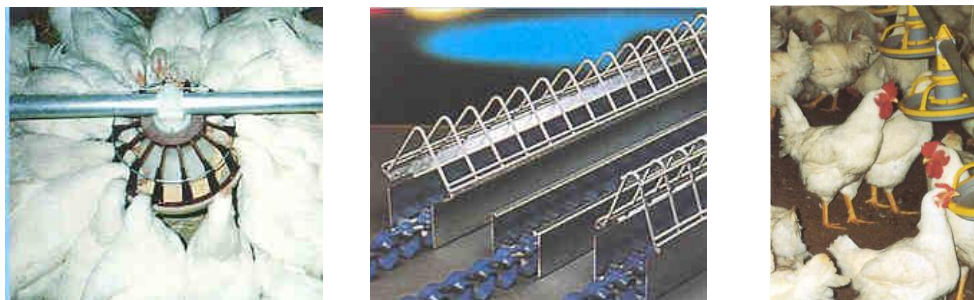
Examples of pan feeder systems

Pan feeders may be relatively expensive but feed is distributed immediately into all pans from feed remaining in the tube. The system is then filled from the end but again the feeder length should not be too long. Pan feeders are generally more difficult to manage as each pan needs to be adjusted to ensure even distribution of feed, especially in controlled feed of broiler breeders.

1.6.4.3 Male Feeders

Male feeders are used in broiler breeder operations. The male feeders consist of a pan feeding system which is lifted away for filling and then dropped to a height which disallows the shorter female access to the feed. The female feeders are equipped with a grid mechanism prohibiting access by the males as a result of their larger head and comb. The grid size should be in the order of 45 mm x 55 mm to exclude males from the female feeders.

These feeders should ensure that feed is distributed within a period of 2 to 3 minutes to all birds under conditions of controlled feeding. The male feeders should be large enough to ensure free access of the males to the feed.



Grids over female feeders and male feeder at a height where females cannot reach

1.6.5 Feed Weighing

Feed is the most costly item in poultry production and it is essential to gather accurate records on the daily feed intake of birds. With bulk systems this is difficult to judge unless scales are used to weigh feed accurately.

In managing broiler breeders during the rearing as well as breeding period accurate weighing of feed is essential in the application of controlled feeding programs. In smaller operations this may be done by using scales and manually weighing out of the daily feed allocation required.

Dump scales weigh off a fixed amount of feed (lots) at a time into a mini bin. The feed is then conveyed into the feeding system in the poultry shed.

The number of feed tips may then be recorded manually or electronically into a central data base system for calculation of feed consumption or allocation within the period.

Load cells are placed under the bulk feed bin for accurate weighing of the feed within the feed bin. The daily feed allocation may be delivered by augur from the main feed bin into a smaller feed bin equipped with load cells (or with a dump scale between the main feed bin and the smaller bin).



Dump scales and load cells under the feed bin

1.7 Drinker Systems

Water supply equipment has developed from open troughs and bell shaped drinkers which become dirty and contaminated and are difficult to keep clean to more modern nipple drinker systems. Nipple drinker systems are entirely closed and the water in these systems remains clean. These closed systems would also reduce the risk of disease spreading within the flock as compared to open drinkers.

Drinkers are designed for either young (day old chicks) or growing birds and adult stock.

1.7.1 Drinker Space Requirement

The drinker space required would normally be provided by breeder companies of the stock involved.

As a general rule the feeder space for layer and broiler breeders presented in Table 1.3 can be used.

Table 1.3: Drinker space requirement for breeders

| Application | Unit | Space |
|--|----------------|-----------|
| <u>Broiler Breeders</u> | | |
| Chick drinker (fonts) | Chicks/drinker | 100 – 150 |
| Day old to 6 weeks (φ 35 cm) | Birds/drinker | 150 – 200 |
| 7 to 20 weeks (φ 35 cm) | Birds/drinker | 150 – 200 |
| Laying period (φ 35 cm) | Birds/drinker | 150 – 200 |
| Nipple drinker | | |
| Rearing | Birds/nipple | 8 – 12 |
| Laying | Birds/nipple | 6 – 10 |
| <u>Layer Breeders and Pullet Rearing on Floor</u> | | |
| Chick drinkers (fonts) | Chicks/drinker | 100 – 150 |
| Day old to 6 weeks (φ 35 cm) | Birds/drinker | 150 – 200 |
| 7 to 20 weeks (φ 35 cm) | Birds/drinker | 150 – 200 |
| Laying period (φ 35 cm) | Birds/drinker | 150 – 200 |
| Nipple drinker | | |
| Rearing | Birds/nipple | 10 – 12 |
| Layers | Birds/nipple | 6 - 8 |

1.7.2 Drinker Systems for Chicks

Chicks should be started off with equipment specially designed to ensure that water intake is not limited during the initial stages of development.

Chick fonts are manually filled pan and jar drinkers and are popular for young chicks. Water is placed in the jar which when turned will feed water into the trough. These drinker systems are normally used for the first week to 10 days to ensure that chicks get off to a good start.



Example of chick fonts

Low pressure nipples suitable for starting chicks and growing of the birds and which are suspended on drinker lines are popular in large-scale floor operations as they are less labour intensive (no cleaning required) and considered to reduce spreading of disease as

the system is closed. Some types of nipples are equipped with drip cups to eliminate dripping onto litter while others operate without drip cups.

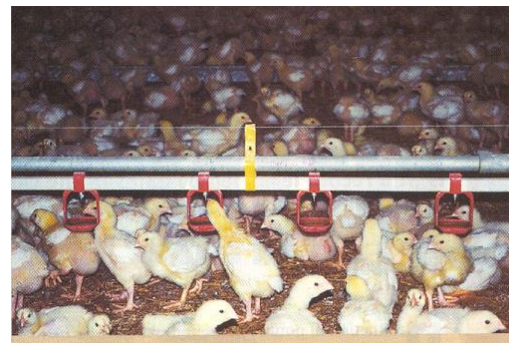
1.7.3 Drinker Systems for Older Breeders

Bell drinkers are plastic drinkers and hang from the ceiling on adjustable nylon cables to suite bird height. They are popular in floor systems. The drinker is equipped with a valve mechanism and spring, which controls the water flow into the trough by means of the weight of water in the trough. These drinkers are often ballasted by a weight in the bell (usually a container filled with water), which reduces swinging and water spillage.



Bell drinkers require regular cleaning

Nipple drinkers have become very popular in both cage and floor systems. The older type of nipple drinkers required a drip cup to eliminate spillage and wet litter. More modern nipples exist which are used without drip cups with a minimal amount of spillage. In floor systems the nipples are suspended on hanging water lines and due to the nipples requiring a constant set pressure, a pressure control mechanism is usually supplied. Water pressure adjusters are also installed where water lines are long and the floor is sloped to one side of the building.



Nipple drinker application in floor rearing of breeders

Various types and makes are available for floor rearing and breeder systems and should be checked as being suitable for what the use is intended for.

1.8 Nesting Systems

Many different types and makes of nesting systems have been developed to save labour and improve hatching egg quality. Whatever the design or make, there are some key requirements:

- Nests should be easily accessible by and attract the birds. Birds prefer nests to be off the floor but not too high, especially in the case of broiler breeders (30 to 40 cm).
- Perches should be positioned in front of the nests to allow birds to walk in front of the nests and select the nest of choice.
- Nests should be placed perpendicular to light and air movement so as to expose the nest and birds to as little light and air movement (draught) as possible.
- Placing the water lines close to the nests will also encourage birds to use the nests
- As a rule with individual nests one nest should be provided per 4 females (30 cm wide x 40 cm high x 35 cm deep) and for community nests 1.25 m² per 100 females should be provided.
- Nests should preferably be able to be closed at night (prevent soiling of nests) and this is of special importance in automated nests with synthetic floors (astroturf).

1.8.1 Manual Nests

With this system eggs are removed manually from the nests and placed onto egg trays.



A monorail down the building from which an egg collection table is suspended will ease the process and reduce breakage. The eggs are then brought to the service passage of the building from where they are transferred onto the conveyor system for removal to the egg room.

1.8.2 Automated Egg Collection Nests

Automated nests are normally placed down the centre of the building and egg belts then convey the eggs to the front where they are transferred onto egg trays, either manually or mechanically by egg packers.



Example of Choretime nests on the left and Big Dutchman nests on the right

1.9 Types of Floor Systems for Breeders

Conventional breeder systems consist of the entire floor area being covered with bedding and equipment (feeders, drinkers and nests) is evenly spaced throughout the floor area. Although more costly, alternate floor types have been developed, especially for broiler breeders where litter conditions in all-litter houses often present problems.

Originally the slatted floor areas were constructed of wood or wire slats but plastic slats, although more costly to install, have become more popular. They are easier to clean and produce less foot pad problems. Compared to all litter floors stocking density on slatted floor systems may be higher due to the improved litter condition.

Slatted floor breeder houses are normally part slats (60 to 70%) and part litter (30 to 40%). Fully slatted floors are normally not recommended, especially for heavy breeds as increased leg problems are experienced. The layout of a typical slatted floor building would consist of two litter areas down the side walls with the centre section covered with slats and the nests placed down the centre, dividing the house into two sections. Feeders and drinkers are then placed on the slatted floor area, with the drinkers closest to the nests to attract birds to the nest area.

Advantages and disadvantages of the all-litter versus slatted floor houses include:

- All-litter houses will generally produce less foot pad problems but litter quality will often be a problem, especially with broiler breeders
- Wet litter conditions in all-litter houses will result in increased dirty nests and hence increased number of dirty eggs.
- It is difficult to ventilate the area below the slats.
- Birds produce more eggs on all-litter floors but this is mainly due to eggs accidentally laid on slats disappearing into the manure area below the slats.
- Floor eggs are higher on all-litter floors but again this is often due to eggs not laid in the nests disappearing into the manure area below the slats.
- Mortality is generally higher on slatted floors due to development of leg problems, especially with heavy breeds and males.
- If breeders have been reared on all-litter houses then it is advantageous to confine the birds to the slatted floor area when moved to partial slatted floor houses. This

is to accustom birds to the slats as they will tend to concentrate in the litter area which they are used to.



Conventional floor system on the left and a slatted floor system on the right

2 Modern Breeds of Chicken

Modern chickens are descendants of the Gallus Gallus of India where the local jungle fowl was domesticated more than 4,000 years ago. For thousands of years, chickens were bred not for their qualities to produce human food but rather for their fighting spirits and their value as novelties like odd shaped comb, presence of a crest on the head plumage, feathers on the feet, etc. By the year 1,000 AD, chickens were being raised on farms as far apart as Iceland, Madagascar, Bali and Japan.

For many centuries chicken farming flourished in Asia and superior breeds were developed. In Europe chicken farming remained a marginal undertaking and after the religious wars and revolts of the 16th century chickens ceased to be a common sight. In the 18th and 19th centuries, quality breeds were introduced from Asia and this again stimulated the economic importance of chicken in the Western World.

In the early days of poultry production in South Africa, which took on the form of a commercial industry after the Second World War, most breeds used were pure lines. Gradually breeders started developing cross breeds in which hybrid vigour (heterosis) was used to enhance the performance of progeny to higher levels than the parents.

Dual-purpose breeds for meat and egg production existed but breeders later developed separate specialized lines for the poultry meat and egg production industries.

Many breeders existed in South Africa prior to 1970, but during the 1970's when importation of superior stock was allowed under the Livestock Improvement Act of 1973, most of them either formed franchise arrangements with overseas breeders or simply ceased to exist. Some of the larger companies in the egg and broiler industries preferred to form their own franchise arrangement with overseas breeding companies and in so doing became large integrated businesses, operating Grand Parent, Parent and Commercial Production operations.

Worldwide pressure for improved stock performance and the cost involved in running pure line breeding programs has resulted in the number of breeders throughout the world to decline. At present both in commercial layer and broiler breeding, the pure line programs are under the control of very few companies. In each of the egg and poultry meat industries, three to four breeding companies would be producing up to 90 percent of the stock used in the world's poultry production.

2.1 Chicken Breeds

Although other breeds of chicken have been and are still being used in the development of modern lines of chicken, most of the commercial stock available originate predominantly from four basic breeds, two in the production and development of egg breeding lines and two in the production and development of meat production lines.

In the breeding for egg production single comb White Leghorn and single comb Rhode Island Red are used to form the core of most breeding programs, although other breeds such as the New Hampshire and Sussex may form part of the breeding program as well.

In the breeding of meat production lines the White Plymouth Rock and the Cornish Game breeds form the core of the breeds used. Other breeds may be introduced from time to time, especially when new traits and characteristics are required to be introduced.

2.1.1 Single Comb White Leghorn

Single comb White Leghorns are small bodied birds white feathered birds, have a yellow skin and produce white-shelled eggs. Although Leghorns were used by South African breeders in the production of local cross bred egg strains, their popularity waned when modern cross bred brown egg lines were introduced from Europe and USA during the 1970's. As a result of the smaller body size, the end of lay bird has little value in South Africa compared to larger bodied birds normally found in brown egg strains. For this reason as well as consumer preference for brown shelled eggs, the White Leghorn is not popular in South Africa.

2.1.2 Single Comb Rhode Island Red

This bird is dark brown feathered with some black on the tail, neck and wings, has a larger body compared to Leghorns and produce eggs with brown shell colour. This breed of bird has played a major role in the development of modern, colour sexed, brown egg strains throughout the world, especially in Europe. The Rhode Island Red was also used in the development of "silver strains" (white feathered bird producing brown eggs) which are used in many modern cross breeding programs of feather sexed brown egg layers.

2.1.3 White Plymouth Rock

This is a heavy breed of bird with white feathers, white skin and has a large appetite. This breed makes up the basis of breeding programs developed for the female lines by breeders of meat type birds. The original lines of this breed were slow feathering and due to the preference of many broiler producers for fast feathering broilers most strains today are fast feathering. Slow feathering lines do exist which are used to feather sex broiler progeny for separate sex rearing at commercial level.

2.1.4 Cornish Game

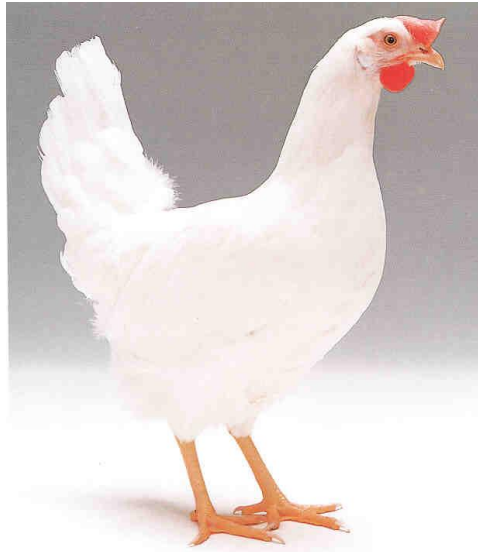
This bird produces a brownish colour egg (tinted) is white feathered and is yellow skinned. The legs are short and the body is broad with a wide and muscular breast. This breed's carcass features are desirable for broiler growing but its low egg production characteristics and poor hatchability are negatives in broiler breeding. Cornish lines have been crossed with Plymouth Rock and other breeds such as New Hampshire, in the development of modern cross bred broiler lines.

2.2 Modern Egg Producing Lines

Specially developed egg production lines are used for the reproduction of pullet chicks which are destined for the production of commercial eggs for human consumption. Two basic lines are available from most breeding companies and include birds that produce eggs with white shell colour or eggs with brown shell colour. Some breeders do have lines available that produce eggs with tinted shell colour.

2.2.1 Modern White Egg Layer Strains

The white egg lines are small bodied with low aptatite, high rate of production and egg output and low feed conversion.



Practically all commercial white egg layers are Single Comb White Leghorns originating from two or more pure lines. Most breeders use cross breeding of two or more lines to utilize the effect of heterosis. Hybrid vigour, or heterosis, is the result of two pure lines, each being homozygous for various traits that are selected for, being mated and the progeny showing superior results compared to both the parent lines in one or more of the traits.

Breeders use closed flock selection, keeping families of birds and using the data of first year performance to select families showing performances which are generally in the desired direction required for selection. Only a few birds are used for reproducing progeny for the next generation. Many features will enter into the selection criteria and the more traits to be selected for the slower the genetic improvement will be for the traits being selected for.

The main problem in layer breeding is the evaluation of the male in respect of its ability to reproduce siblings showing desired egg production traits for which the breeder is selecting. This is achieved through a process of doing reciprocal mating (i.e. males of one line mated to females of the second line and females of the first line mated to males of the second line) and pure line mating (i.e. males of line one crossed with females of line one).

The next generation is then selected on the basis of the performance of the parents as well as the performance of half sibs (sisters). This process is repeated in each generation (recurrent) and this process of breeding in layer strains is then commonly referred to as Reciprocal Recurrent Selection.

Strain crossing and testing of the ability of one strain to cross well with another strain also has to be done. Certain traits may be selected for in the male or female line (or in a particular strain to be introduced in the breeding program). Introducing these lines in the breeding program then produces the commercial pullet carrying traits of all the lines. A simplified version is where two strains are developed, the male and female line, and then mated in a single crossing to produce commercial pullets. Three or four line crossing may be used in more intricate breeding programs. In short the breeder resorts to the keeping of various pure lines and the continual improvement of all lines and testing of the progeny of various line crossing for the traits which are used in the program.

Due to the small body weight as well the consumer preference for brown shelled eggs, white egg layers are not commonly used in South Africa by commercial egg producers. They are however very popular in countries such as USA, Japan and China.

2.2.2 Modern Brown Egg Layer Strains

Shell colour has no effect on the nutritional value of the egg yet certain countries prefer brown eggs. Brown egg layers are generally heavier in body mass compared to white egg layers, resulting in poorer production and feed efficiency. Continued selection pressure on brown egg lines has however improved breeds producing brown eggs to such an extent that in many production criteria they are currently very close to white egg layers. Most commercial brown egg layers consist of a Rhode Island Red male line crossed to a Cornish type female line (generally referred to as the Silver Line) which could have other breed characteristics bred into the lines. The progeny is colour sexed at day old in commercial hatcheries.



In South Africa special brown egg layers have been developed by most suppliers of commercial pullets where the reverse cross of two or more lines (Silver Male crossed with the Rhode female) is used. The commercial pullet will generally produce smaller egg size compared to the normal cross and will have a large appetite and body mass, compared to the normal cross. The progeny of this cross is usually feather sexed at day old.

Much the same breeding techniques described for white egg laying strains are used in the development and improvement of brown egg layers.

2.3 Modern Meat Producing Lines

In the past dual-purpose breeds were used for the production of poultry meat, but since the late 1960's, specialised meat strains have been developed for this industry. The emphasis of these strains has been on weight gain and feed conversion of the broiler progeny. The requirement in certain markets for higher percentage breast meat compared to thigh and drumstick has resulted in specific lines being developed for this "cut-up" market compared to other markets where total body weight gain is the market criteria. For this reason suppliers of commercial meat breeding stock have developed various products suited for the different market requirements that exist throughout the world.



Breeders of meat breeding stock have placed much emphasis on skeletal development and the bird's respiratory and blood circulatory system to cope with the tremendous growth that the modern broiler is capable of achieving. The latter is of special importance when broiler progeny is to be grown at altitude which places additional strain on the respiratory and cardiovascular system of the bird. This is achieved by breeding and selection of the stock at altitude or by use of respiratory chambers in which high altitude is simulated.

Generally, it is very difficult to breed for weight gain as well as egg production and good hatchability due to these traits being negatively correlated. Selection pressure in one trait usually results in a decrease in the other.

Breeders will resort to line crossing, in the development of a female line, which is reasonable in terms of egg laying and hatching ability, traits that are needed for the production of broiler chicks. This female line is then crossed to a male line specially selected for weight gain, body confirmation, liveability, etc. The effect of heterosis is then also used in the crossing of such lines.

Some breeders have developed products that are more suited for the production of commercial parent stock which have the ability to produce more eggs (day old broiler chicks) at the expense of body mass in the progeny. These products are generally much easier to manage as parent stock. Other products which require meticulous management

control at the parent stock level are preferred by producers who are more interested in broiler performance.

The ability to feather sex the commercial broiler chick has been bred into some products to separate the male from female broilers at day old. This is however only used in very large broiler operations who would be interested in rearing the sexes separately. The added problem with the feather sexed strains is that the male commercial stock is slow feathering, which could pose a problem if housing conditions are not ideal.

2.4 Commercial Breeding Schemes in South Africa

Most breeders will use line crossing where pure lines are crossed to produce what is generally referred to as Great Grand Parent Stock (GGP). These birds are used in a multiplication program to produce Grand Parent Stock (GP) which in turn are used to produce Parent Stock (PS).

Suppliers of day old chicks in South Africa import Great Grand Parents or Grand Parent stock into the country on a regular basis. From this stock, parent and commercial chicks are produced.

Some broiler breeder programs in South Africa incorporate a certain amount of local selection for resistance to ascites. This would mean the importation of Great Grand Parent stock with some pure line selection at high altitude.

Importers of the stock could be a totally integrated business in which the entire production scheme is controlled within the company. Stock could be made available to competitors at any stage within the production scheme. In other instances the importer of stock could not be an integrated business and stock is then made available to customers at any stage of the scheme, without any control of commercial production activity.

2.5 Auto Sexing Lines

Vent sexing of day old chicks is a laborious task, requiring staff with specialised training and skills. Various breeds of chicken exist in which a characteristic linked to the chromosome determining the sex of the bird is used to distinguish between male and female chicks. This is generally referred to as auto-sexing and is done either by the sexed linked characteristics of plumage colour (colour sexing) or rate of feather growth (feather sexing).

2.5.1 Feather Sexing

Slow feathering in young chicks is due to a qualitative sex-linked dominant gene "K". Its allele, rapid feathering, is the result of the recessive gene, "k". The predominant feature of the recessive gene is to cause feathers to develop slower during the initial 6 to 8 weeks of the bird's life. The difference between slow and fast feathering can already be detected at day old by the difference in length of the primary wing feathers in relation to the length of the wing coverts, which are the small downy feathers covering the base of the primary feather shafts. A variation in rate of slow feathering as opposed to fast feathering does however exist and it is often difficult to fix this genetic trait in the breeding lines.

To understand the genetic fixing of this it is necessary to understand the genetics of sex determination. Sex is determined by the sex determining chromosome known as the Z and W chromosomes. In poultry the Z chromosome is fully developed and functional in as much that genes are carried in the normal way. The W chromosome is atrophied and therefore when linked to the Z chromosome only the Z chromosome will determine gene characteristics carried on that particular chromosome.

In poultry males are then identified as having ZZ chromosomes whilst females have ZW chromosomes.

| | | | | |
|---|-----------|-----------|-----------|-----------|
| Makeup of the parent sex chromosomes | ZZ | | ZW | |
| Makeup of the gametes (sperm and egg cells) | Z | Z | Z | W |
| Possible make-up of progeny | ZZ | ZZ | ZW | ZW |
| Sex of the individual | Male | Male | Female | Female |

The genes determining the rate of feather growth are carried by these chromosomes.

kk is a homozygous fast feathering male
 Kk is a heterozygous slow feathered male (slow feathering is dominant)
 KK is a homozygous slow feathered male
 K- is a slow feathered female (now genes carried on the W chromosome)
 k- is a fast feathered female

Should a homozygous rapid feathering male "kk" be mated to a slow feathering female K-, the feathering of the parents and progeny will be as follows:-

| | | | | |
|---------|-----------|----|-------------|----|
| Parents | kk (Male) | | K- (Female) | |
| Gametes | k | k | K | - |
| Progeny | kK | kK | k- | k- |

Since these genes are carried on the sex chromosome (Z), the sex and feathering of the progeny are determined at the same time as follows:

| | | | | |
|------------|-----------|-----------|------------|------------|
| Sex | ZZ(Male) | ZZ(Male) | ZW(Female) | ZW(Female) |
| Feathering | kK (Slow) | kK (Slow) | k- (Fast) | k- (Fast) |

(K is dominant slow feathering and k is fast feathering)

Note that this sex linkage is lost with the next generation as the male has to be homozygous fast feathering and the female hemizygous slow feathering.

This then expressed as slow feathering males and fast feathering females at day old as illustrated below.

Feather Sexing



Slow Feathering Male

Fast Feather Female

2.5.2 Colour Sexing

Another sex-linked gene S that produces silver feather colour (a certain type of white) is dominant over the recessive allelomorph s, which produces gold feather colour. Since this gene is also carried on the sex chromosome chick colour can be linked to the sex of the chick.

- SS is a Homozygous silver or white male
- Ss is a Heterozygous silver or white male (silver is dominant)
- ss is a Homozygous gold male
- S- is a Silver female
- s- is a Gold female

The gold male will always be ss and a silver female S-. Should they be mated the progeny will always be as follows: -

Should a Gold male be mated to a Silver female the progeny will always be as follows: -

| | | | | |
|---------|----------------|----|--------------------|----|
| Parents | ss (Gold Male) | | S- (Silver Female) | |
| Gametes | s | s | S | - |
| Progeny | sS | sS | s- | s- |

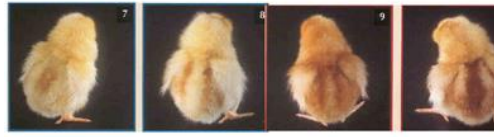
Since these genes are carried on the sex chromosome (Z), the sex and feathering are determined at the same time as follows:

| | | | | |
|--------|-------------|-------------|-------------|-------------|
| Sex | ZZ (Male) | ZZ (Male) | ZW (Female) | ZW (Female) |
| Colour | sS (Silver) | sS (Silver) | s- (Gold) | s- (Gold) |

This due to silver being dominant over gold.

The progeny will then be colour sexed at day old as illustrated below.

Colour Sexing



Males

Females

3 Reproduction and Egg Formation

In the fertilized egg the reproductive cells are comparable to that found in mammals. In the case of the chicken egg however, yolk, albumin, shell membranes and the shell itself accompany the reproductive cells.

The process of egg formation in the female hen occurs in the oviduct after fertilization has taken place in the infundibulum. Some cell division takes place immediately after fertilization, but in the chicken, this process can be stopped and re-started again at a later stage.

After fertilization has taken place in the infundibulum, the yolk moves down the oviduct and albumin material, the shell membranes and eventually the shell itself is deposited around the yolk and the egg is laid some 24 to 25 hours after ovulation.

3.1 Male Reproductive Organs

The male reproductive system consists of two testicles in the dorsal area of the body cavity, just in front of the kidneys. The many ducts of the testes lead to the vas deferens and vas deferens, which carry the sperm from the testicles to the papillae in the dorsal area of the cloacae. From here semen is conveyed to the copulatory organ located in the folds of the cloacae.

Sperm is stored in the vas deferens where it is diluted with lymph fluid and both are ejaculated as a mixture during copulation.

The phallus of the male chicken is very small, but waterfowl have a well-developed, long and twisted organ. During copulation the cloaca of the female opens to expose the end of the oviduct, and semen is deposited over this opening and finds its way up the oviduct from there.

3.2 Female Reproductive Organs

The female reproductive organs consist of two main parts, namely the ovary and the oviduct.

3.2.1 Ovaries

At the time of early embryonic development, two ovaries and two oviducts develop in the female chick, but the right set atrophies, leaving only the left ovary and oviduct at time of hatching. Prior to sexual maturity the ovary is a mass of small follicles containing ova. Several thousand are present in each female, which is many times the number that will eventually develop into full size yolks in the lifetime of the bird.

At sexual maturity the ovary undergoes many changes due to hormonal activity. Follicle-stimulating hormone (FSH) is produced by the anterior pituitary gland situated just below the brain. In turn the active ovary begins to produce other hormones such as estrogen and progesterone called sex steroids.

It is the higher level of estrogen in the blood, which leads to the development of medullary bone, stimulates yolk protein and lipid formation in the liver, and the increase

in the size of the oviduct. This enables the production of albumen proteins, shell membranes and the cuticle and calcium carbonate for shell formation. Many ova are in different stages of development and about 10 days are required for a single yolk to mature. The yolk consists mainly of fats (lipids) and proteins, which combine to form the lipoproteins. This yolk material is laid down adjacent to the germinal disc that continues to remain on the surface of the yolk mass.

The yolk is not the true reproductive cell but rather the source of food supply from which the minute cell (blastoderm) and its resultant embryo will sustain its growth. Where birds are kept in cages, no fertilization will occur and the blastodisc will be similar to that of an unfertilized breeder egg.



The Ovaries

3.2.2 Oviduct

The oviduct is a long tube through which the yolk passes and in which the rest of the egg is formed. In growing pullets this organ is relatively small but increases in size with onset of sexual maturity. The segments of the oviduct are the Infundibulum, Magnum, Isthmus, Uterus and Vagina.

3.2.2.1 Infundibulum

The Infundibulum is the funnel shaped upper part of the oviduct and its purpose is to “catch” the yolk as it is released from the cluster of ova. The yolk remains in this section for only approximately 15 minutes, before being forced further down the oviduct by contractions.

If birds are kept in the presence of males within 15 minutes of ovulation a few sperm will find their way to the area of the pronucleus on the surface of the yolk. Three or four sperm may enter but only one eventually unites with the female egg cell to form a new individual, the zygote.

3.2.2.2 Magnum

The magnum is the albumen-secreting portion of the oviduct and is approximately 30 cm in length. The developing egg spends about 3 hours in the magnum during which the albumin is deposited.

Upon breaking an egg, two twisted cords known as the chalazae can be seen extending from opposite poles of the yolk through the albumen. The chalaziferous albumen is produced when the yolk first enters the magnum, but the twisting to form the two chalazae occurs later as the egg rotates in the lower end of the oviduct. The purpose of the chalazae which is twisted in opposite directions is to keep the yolk to the centre of the egg.

As the developing egg passes through the magnum the inner white followed by the dense white and outer white is deposited.

The dense white makes up the largest portion of the egg albumen. This dense white contains mucin that tends to hold the albumen together.

After the egg has been laid, there is a constant change in the interior content of the egg. The thick white does not retain its viscous composition and its volume decreases in relation to the thin white. High storage temperatures enhance this process.

3.2.2.3 Isthmus

The isthmus part of the oviduct is short and the egg remains in this part for approximately 75 minutes. The inner and outer membranes are formed in the isthmus. The shell membranes are not completely filled with contents at this stage and the egg resembles a sack that is partially filled with fluid.

The shell membranes are papery and composed of protein fibres, the inner shell membrane being deposited first. The membranes are held close together but separate at the rounded end of the egg where the air cell will be formed. This air cell only develops after the egg has been laid and increases in size to about 1.8 cm.

As the egg ages, the interior contents dehydrate and the air cell increase in diameter and depth. Conditions, under which the egg is held (temperature and humidity) as well as shell thickness, will affect the rate of dehydration of the egg content and hence the rate at which the size of the air cell will increase.

3.2.2.4 Uterus

The uterus part of the oviduct is primarily the shell gland. The developing egg remains in the uterus for 18 to 20 hours.

By a process of osmosis, water and salt are added through the shell membranes to "plump" out the loosely adhering shell membranes, forming the fourth layer the outer thin white.

Small clusters of calcium appear on the outer shell membrane just before the egg leaves the isthmus. These are the initiation grains for calcium deposition and their number is probably inherited and plays an important role in amount of calcium deposition that will occur later. They disappear a short while after the egg enters the uterus. The shell

consists of the initial mamillary layer (spongy calcite crystals) and the outer shell, which is made up of hard crystals. The completed shell consists almost entirely of calcium carbonate with small deposits of sodium, potassium and magnesium.

The sources of calcium are the feed and certain bones. Medullary bone serves as a calcium reservoir, especially at night when birds are not eating and shell is being deposited.

Several factors influence shell quality and include:

- Age of the bird. This is believed to be due the bird not being able to deposit sufficient calcium carbonate to cover the larger egg
- Increased environmental temperatures
- Stress affect shell quality
- Certain poultry disease will affect shell quality
- Certain drugs will affect shell quality
- Certain breeds have poorer shell quality than others
- Nutrition will affect shell quality. This includes availability of calcium in the raw materials as well as other nutrients such as especially phosphorus and vitamin D.
- The size of the calcium source is also believed to play a role. Coarse calcium will remain in the intestinal tract for a longer period which makes calcium available in the blood stream later at night when shell is being deposited.

3.2.2.5 Vagina

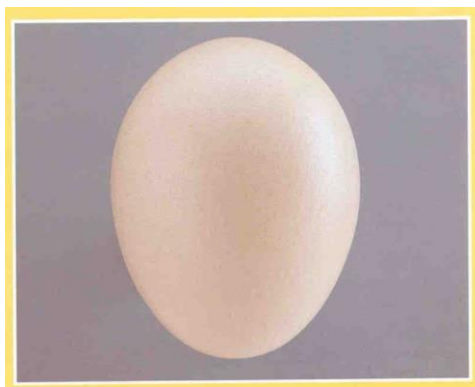
The vagina is the last section of the oviduct prior to the cloacae and vent and is about 12 cm in length.

In this part the cuticle, which gives the shell a shiny/waxy appearance, is deposited.

The egg eventually passes through the cloacae and vent, roughly 25 to 26 hours after ovulation.

3.3 The Chicken Egg

The egg consists of four main parts namely the Shell, the Shell Membranes, the Albumin and the Yolk.



3.3.1 The Shell

The shell consists almost entirely of calcium carbonate (90 to 95%) and comprises 10 to 12% of the weight of the whole egg. The shell consists of an inner mamillary layer and an outer spongy layer.

The spongy or crystalline layer is the main part of the avian shell and is largely responsible for its mechanical strength. It consists of elongated structures that are perpendicular to the shell surface. Pores through the calcified layer permit diffusion of gases and water vapour.

Chemically the calcified layer is mainly calcium carbonate.

3.3.1.1 Shell Cuticle

The cuticle is a thin layer on the outside of the shell which gives the freshly laid egg a glossy-like appearance (bloom). The function of the cuticle is not clear but it may be speculated that it helps repel water, it may assist in increasing shell strength and it could also play a role in preventing microbial penetration.

3.3.1.2 Shell Pigments

Pigments in the eggshell are confined to the cuticle and outer part of the calcified layer. The only commercial importance of shell colour is that certain geographic regions (markets) have preference for brown-shelled eggs as opposed to white shelled eggs. The brown pigment in brown egg layer strains are porphyrin derivatives of haemoglobin metabolism and are deposited during the last two hours of shell formation. The three main pigments are protoporphyrin, biliverdin IX and its zinc chelate. Protoporphyrin tends to give a more brownish shell colour and the biliverdins blues and greens. Breeders of brown shell layers are continuously selecting for more uniform and intense brown shell colour. The brown pigmentation declines towards the end of lay. White eggshells contain a very small amount of pigment.

3.3.1.3 Microbial Contamination

Microbial contamination may occur even before the egg is laid but the incidence thereof is very low. It is important for producers of eggs for hatching purposes to ensure that flocks are regularly tested for bacterial infections such as salmonella that may be passed on to the progeny via the egg. These conditions are referred to as being transmitted vertically.

Most contamination occurs immediately after the egg has been laid and the main sources of microbial infestation include:

- The cloacae
- The atmosphere
- Dirty equipment
- Dirty hands of staff handling eggs

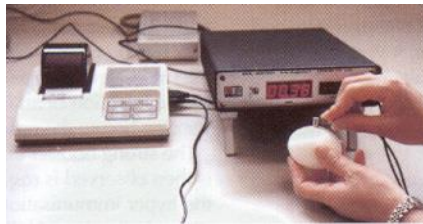
Poor handling resulting in hairline cracks causing easy penetration
Poor environmental conditions
Poor storage
Poor washing of eggs if practiced

3.3.1.4 Shell Strength

Shell Strength is an important genetic trait and especially so in layer breeders. Methods used by breeders to determine shell strength include:

Specific gravity
Deformation
Compression (laterally and longitudinally)
Puncture (with fast and slow moving objects)
Impact

Selection for improved shell strength, especially towards the latter part of the production cycle remains a priority for all layer breeders. It is not such an important trait in broiler breeding but is nevertheless not ignored in these breeding programs.



Determination of shell thickness

3.3.2 The Shell Membranes

Two shell membranes, the inner and outer membranes, are found just below the shell. They are adjacent to one another except for the broad end where they are separated by the air cell. The membranes retain the fluid of the albumin and other biological functions include the anchoring of the embryo and resistance to penetration of micro-organisms.

The two shell membranes are separated at the round end of the egg to form the air cell. In a fresh egg, the cell is approximately 15 to 20 mm in diameter and 3 to 4 mm in depth. As the egg ages, the diameter and depth of the cell will increase and the speed at which this happens will depend primarily on the temperature at which the egg is kept. At colder temperatures, the increase in size will be retarded while it is enhanced at higher temperatures.

The air cell can be seen when candling and enlarges during the process of incubation. This is also the area into which the beak of the developed chick will move during hatching when the process of respiration starts towards the end of the incubation process. This is the reason why embryonic development must occur in the correct position to

ensure that pipping is in the correct place of the egg and that the chick is properly orientated in respect of the air cell, when hatching.

3.3.3 The Albumin

The albumin makes up the larger portion (58%) of the avian egg and may be described as a transparent gelatinous mass surrounding the yolk, consisting of 88% water and 12% dry matter. The functions of the albumin include:

- Prevention of growth of micro-organisms
- Provide water, proteins and other nutrients for the developing embryo
- The Chalazae holds the inner thick and yolk to the centre of the egg

The albumin consists of different layers of outer and inner thin white, the percentage of which could vary but in general would be found in the following proportion:

| | |
|-------------|----------|
| Outer thin | 23% |
| Outer thick | 55% |
| Inner thin | 20 |
| Inner thick | 2% |
| Chelazae | (< 0.5%) |

On a flat surface the albumin of a fresh egg has a heaped jellylike appearance. By contrast, the albumin of an old egg, especially when stored under poor conditions is more fluid and less viscous. A fluid like albumin is an indication of an old egg, although some birds will produce eggs with watery whites, especially when certain diseases are present.

This firmness of the albumin is used as an indicator of freshness of or interior quality of the egg and the measure is generally known as the Haugh Unit Measure.



An electronic Haugh meter with egg yolk showing the chalazae and firm white

3.3.4 The Yolk

The proteins and lipoproteins of the yolk are not synthesized by the ovarian tissue but in the liver from where they are transported by the blood system to the ovaries. The liver undergoes major changes during the few weeks prior to commencement of production in which anabolic activity intensifies and this activity ceases completely once lay no longer

occurs. Liver disorders are often associated with egg layers and commonly referred to as fatty liver syndrome.

Yolk comprises mainly of water, lipids and protein. It makes up roughly 31% of the whole egg and contains 48% water and 52% dry matter.

The main function of yolk material is to provide metabolic energy and nutrients to the developing embryo.

3.4 Fertilization

Unlike mammals, the chick embryo develops from food stored in the egg rather than from the blood supply of the mother. Although some development of the embryo takes place in the hen prior to the egg being laid, most development takes place outside of the hen's body and this development is much more rapid than in the case of mammals.

Fertilization may occur through natural mating or by means of artificial insemination.

Cell division continues to occur immediately after fertilization as the egg moves down the oviduct. This early embryonic development prior to the egg being laid (pre-oviposital) comes to an end shortly after the egg is laid and for all practical reasons ceases when the egg is kept at a temperature below 24°C. This temperature is often referred to as the threshold temperature of embryonic development.

3.4.1 Natural Mating

A male could mate from 10 to 30 times per day, depending on the availability of females. The physiological processes that will provide a sufficient number of sperm at the appropriate time for fertilization of the ovum in the infundibulum before the inner white is secreted are not fully known. Sperm are stored in the sperm storage tubules located at the junction of the shell gland and the vagina of the oviduct. Sperm may be released continuously from the sperm storage tubules to provide a constant number of sperm in the infundibulum or they may be released from the tubules by mechanical distension, as the tissue is stretched by the passage of an egg at oviposition.

After a single mating, fertile shell eggs will be produced within 20 hours, but normally maximum fertility will not be reached until the third day. Frequency of mating varies between females and could occur every day or up to once every third day. Chickens are polygamous but certain males will mate more often with certain females. Some females will show avoidance of specific males. Certain breeds will also mate less often.

Cold as well as hot environmental temperatures will reduce normal mating activity and the optimum temperatures for both the male and female is in the region of 20 to 25 °C.

A sequence of behaviours is noticed during mating. This is initiated by "courtship behaviour" of the male which includes dropping of the wing and dancing in a circle. The hen will then crouch to indicate reception of the male. The courtship may often be left out and some females will crouch directly at the approach of a male. The male will mount, grabbing the hen by the comb or neck feathers and tread on the hens back with the hind toes gripping behind and under the wings. The male then dips his tail to the side of the hen's tail and spreads his tail feathers so that his cloacae makes contact with the

protruding cloacae and vagina of the female. The ejaculate is so deposited directly into the vagina via the cloacae.

The ejaculate contains millions of sperm at a time with greater concentration during early morning compared to late afternoon when depletion has occurred due to frequent mating. The initial ejaculate volume will also be larger (1 ml) and this reduces as the day progresses.

Mating behaviour is higher during early morning and again during late afternoon.

Should males be removed from the flock, some fertile eggs will be produced for as long as 4 weeks after removal of males. The fertility will however decrease each day and is more rapid after the fourth day. New sperm are however more viable than old sperm and should males be removed and new males introduced, the new males would have fertilized practically all eggs after the third to fourth day. The introduction of new males to a flock is generally referred to as "spiking".

Breeds differ greatly in the percentage fertile eggs produced. In general, broiler breeds have a better rate of fertility compared to egg production strains due to a higher selection pressure having been applied in broiler breeds for this trait. At onset of production, the percentage of infertile eggs could be high but decreases to 2 to 4 percent at peak production. This figure will again increase towards the end of lay as the flock ages (8 to 10%). In broiler breeds especially, excessive body mass will result in reduced fertility and modern feeder systems have been developed to feed broiler males separately from females in order to control their body mass more effectively.

In natural mating systems, birds are mated at ratios of between 8 and 12 females per male, depending on the breed and systems being used. Heavy breeds will tend to have a higher mating ratio (more males per female) compared to light breeds.

3.4.2 Artificial Insemination

Artificial insemination is often practiced in pedigree breeding situations. Some parent operations have introduced AI in specialized caged systems but the merits of AI in parent operations are prohibited by the high labour expenses and cost of cages.

Semen is collected by massaging of the abdomen below the pelvic bone as well as the back area behind the tail feathers. The ejaculate is then gently squeezed from the protruding papillae into a vial. The semen is transferred into a syringe and diluted with special diluents before 0.025 to 0.035 ml is transferred to the oviduct of the hen, at a depth of about 2.5 to 5.0 cm into the inverted vagina by means of a syringe. This is also achieved by gently massaging of the back and cloacae area of the hen. The semen must be fresh and inseminations must be repeated every 5 to 7 days to maintain optimum fertility.

Number of males required in artificial insemination (AI) is much less and this, together with the fact that the semen is diluted provides the advantages of AI in pedigree breeding operations where the reproduction of progeny from top males can be enhanced. With AI one male can produce sufficient volumes of diluted semen to fertilize 100 to 150 females on a weekly basis.

Avian semen is difficult to store. Males should be “milked” three times weekly and although fertility will not be impaired if semen is collected more often, the semen volume will reduce. Although some diluents are being developed that could show increased storage application, insemination should be done quickly after collection of semen. Freezing and thawing reduces fertility by one half.

Semen collected in the morning will have a greater volume, greater sperm mobility and a higher sperm concentration.

3.4.3 Early Embryonic Development

Fertilization occurs within 15 minutes following ovulation and this occurs while the ovum is in the infundibulum. As the egg moves through the reproductive tract of the female, the albumin, and shell membranes are added and eventually the shell itself. At the time that the egg enters the uterus (5 hours after ovulation), the zygote is at the first stage of first cell division.

The Blastoderm

The egg will remain in the uterus for approximately 20 hours during which the shell is formed and in this period, approximately 16 cell divisions will occur, to produce the blastoderm containing 50,000 to 60,000 cells. It is therefore important to regard fertile eggs as being at a reasonable advanced stage of embryonic development.

At this point blastoderm consists of three distinct layers of cells from which all the organs and parts of the body will develop.

The ectoderm is the uppermost layer of cells and gives rise to the nervous system, parts of the eyes, feathers, beak, claws and skin.

The endoderm is the lower layer of cells from which the respiratory system and secretory organs as well as the digestive track develop.

The mesoderm is the third layer between the two mentioned above and forms the skeleton, muscles, blood system, reproductive organs and the excretory system.

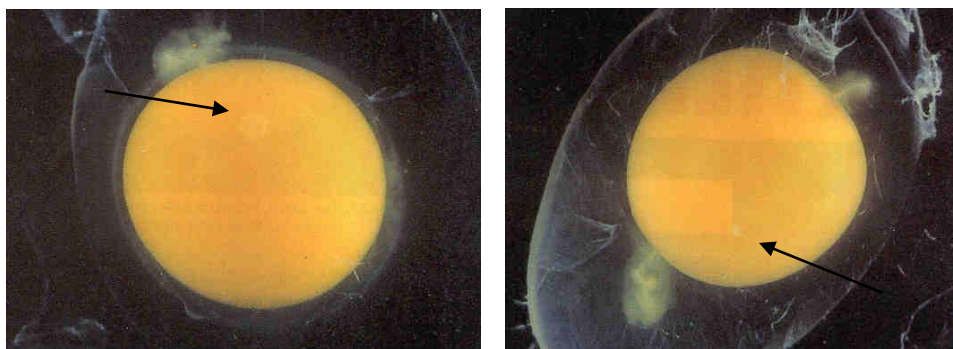
The embryo in the newly laid egg will cease development and cell division when temperature drops below 24°C. Hatching eggs are therefore generally stored at 18°C when kept for short periods of time. A colder temperature is applied (12°C) when eggs are stored for longer than 7 days. The cessation of embryonic development is reversed when egg temperature is increased again to levels above 24°C and the development will be sustained at temperatures of approximately 37°C.

3.4.4 Fertility

3.4.4.1 Determination of Fertility Prior to Incubation

It is possible to distinguish between fertile and infertile eggs prior to placement in the incubators. The egg must be broken out on a white plate or flat surface and the germinal disc (blastoderm) found. This is often the more difficult part as the germinal disc could have landed under the yolk. For this reason the egg is often broken into the hand to enable turning of the egg contents to find the germinal disc.

Prior to hatching a fertile egg will show a large germinal disk (3 to 4 mm in diameter) with a light centre and a thick, white perimeter. It appears like a doughnut, with the thick, white circle around the outer perimeter of the disc. An infertile egg will show a smaller germinal disk with a solid, bright white centre, which may or may not be in the centre of the disc. The white centre of the infertile egg is much brighter than the white centre of the fertile egg. The germinal disk could in the odd occasion be large but the centre will be solid and bright and the perimeter will be irregular.



Fertile egg on the left and an infertile egg on the right

Fresh egg breakout has the advantage that it is the quickest way of determining fertility (even before incubation starts) but it does have the disadvantage that it is a slow process and valuable eggs have to be broken.

It is however a good practice at the start of a new flock to know in advance what the fertility would be like as well as when disease and fertility problems are being encountered. Fertility can be determined on the day that the egg is laid rather than having to wait for 3 weeks until final hatching.

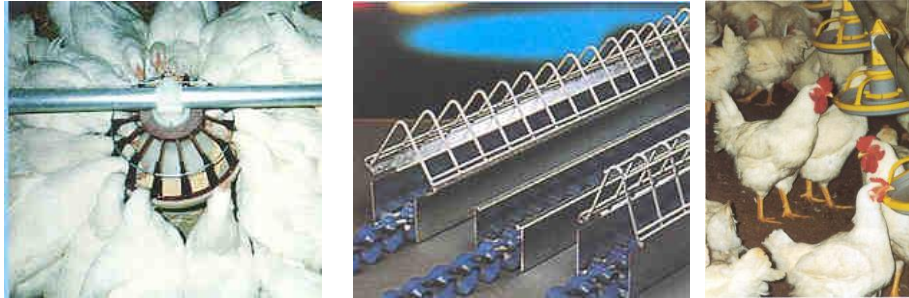
Because of the value of hatching eggs, sample size of 100 eggs should suffice but results could be variable as a result of the small sample size. Fresh egg breakout is generally only done when specific problems are being investigated.

3.4.4.2 Effect of the Male on Fertility

Since half the germ plasma of the developing embryo comes from the male, the few males in the breeder pen play a significant role in the reproductive performance of the flock. The role of males therefore cannot be over emphasized.

Mating ratio is important, as too many as well as too few males will affect fertility. No fixed rules exist, as this will depend on the breed as well as other factors affecting male activity. In general however light commercial layers (Leghorns) will be mated at a lower ratio (7 to 8 males per female) compared to heavy meat type breeders (10 to 11 males per female). Brown egg layers are mated at a ratio of 8 to 10 males per 100 females. Aspects such as the pressure on culling peck outs, general culling of males and housing systems will all play a role in the ideal ratio of males in the poultry shed.

Too often the importance of male body weight, especially in broiler breeders is neglected. Excessive male body mass at point of lay as well as excessive weight gain in the breeder house will lead to obese and inactive males. Separate male feeders have been developed for broiler breeder males, which ensure that the males can be fed a different regime (rates and often ration as well).



Example of grids over female feeders and male feeders at a height that females cannot reach

Wire grids are placed over the normal feed troughs that are designed in such a manner that the males are unable to get their larger heads and combs through. Separate feeders are then suspended at a higher height to stop females feeding from these male feeders. There is however a critical period at onset of production just after the flock is mated up, when males are still able to feed from the female feeders. Close supervision and management is required in this period to ensure that all the effort to produce the correct body mass and uniformity at 20 weeks is not undone. For a period the flock may have to be fed as one so that males and females can feed from either system. Once it is noticed that a larger proportion of the males are no longer feeding from the female feeders, the male feeders are then lifted to a higher height.

In layer breeder the opposite is often encountered where males are found to be under weight.

Culling of males would also play a role in fertility. There is a tendency for males to mate with certain females and should a particular male not be active a tendency may exist where his particular females are not being mated with. On the other hand culling of males should be approached with care. In some breeds, should a male which could be at the lower end of the pecking order be removed, the flock will merely find the next bird in the peck order. This aspect should be carefully managed. Should males be dying off or having to be culled at a higher rate than females, then the reasons have to be found and corrected in order to maintain a satisfactory rate of fertility towards the end of the flock's productive life.

Exercising of males through the introduction of grain feeding on the litter in the afternoon could also assist in keeping males active and stimulating mating behaviour. The amount of scratch feed would be in the order of 5 kg per 1000 per day. The grain of choice is whole wheat or oats.

Often males will develop enlarged footpads and hock joints caused by injury and resulting in an infection (staphylococcus) in the joints. This condition could also have a

nutritional background as excessive protein consumption could be the cause of urate deposits in the foot pad area.

Spiking of males is sometimes used to overcome the problem of reduced fertility towards the end of the breeding cycle. This is done by replacing the old males with young males. It is however costly and should be approached with care. It is usually done at night and all old males should preferably be removed and replaced. The younger males should also be sexually mature. When only a part of the males are removed and replaced by younger males, the younger males do not only then have to contend with dealing with older and more dominant females but also with a number of older and generally heavier males.

The mating activity will also be reduced and when diseases such as IB, NCD, etc. occur.

Both extreme cold and hot environmental temperatures, especially when such temperatures prevail over a couple of days will affect mating behaviour and hence fertility.

Although nutrition also plays a role in fertility (vitamins and minerals) under normal circumstances breeder diets are adequately fortified with these nutrients. Practical conditions such as long storage time of feed under very hot conditions and allowing feed to get wet and become mouldy could destroy certain vitamins or create chemical reactions within the feed that make the vitamins and minerals indigestible to the bird. Where feed is to be kept for longer than a week, the use of anti-oxidants and higher fortification of vitamins and minerals should be considered.

4 Breeder Management

The keeping of poultry for the production of hatching eggs includes many practices similar to what is applied in the production of commercial eggs. A breeder manager should therefore have a sound knowledge of all aspects of pullet rearing and egg production as well as practices involved in the production of clean, fertile hatching eggs. In addition, broiler breeders are generally more difficult to manage as they require special practices to overcome the basic genetic inclination for the bird to be heavy and overweight, which impacts negatively on reproductive performance.

During the rearing period the main objective is to achieve the correct weight for age as prescribed by the supplier of the stock. Most programs would recommend good development during the initial period to ensure good development of the immune system and a good body frame and skeletal development. From 6 to 8 weeks of age through the middle part of the growing period the body weight gain eases off a bit and then as sexual maturity is approached and the development of the reproductive organs commences the weekly gain accelerates again into the early part of production.

In most instances floor systems are used in which birds are kept in all litter houses or buildings of which part of the floor area is covered with slats or wire mesh. Colony cages that have been developed for the commercial egg industry have been used in the case of layer breeders.

Artificial insemination is normally only applied in pedigree breeding operations.

4.1 Rearing of Layer Breeders

With layer breeders, males are normally reared together with the females from day old, but this would depend on the breed being used and the extent to which body weight standard for the males and females are being achieved. Guides and recommendations of the breeder company should be studied.

In the rearing period to 18 weeks of age the object is to achieve the body weight for age as suggested by the particular breeder. This would apply to the males as well as the females. The weight of individual birds should be as close as possible to this ideal weight for age (High uniformity). This is normally achieved by feeding appropriate feeds for age on an ad lib basis. Controlled feeding is seldom practiced but may be required if body weights persist to be in excess of the standards suggested. In most instances in the warm climate prevailing in Southern Africa, the difficulty is more often to ensure sufficient body weight development during rearing especially in open sided buildings.

Feed standards and the stages for feeding the various diets would be prescribed by the breeder and this is best left in the hands of reputable feed companies and technical people. A two phase feeding regime using a Chick Starter followed by a Grower Feed is normally prescribed for warmer climates to ensure good body weight development. A third diet (Developer Feed) may also be incorporated by the feed company but this should only be the case if body weight is heavier than prescribed. These diets are formulated in such a manner that the correct body weight for age is achieved when fed ad lib.

Both sexes are weighed regularly (weekly) and minor adjustments to the feed formulation may be required to assure correct mass for age. Layer breeders are seldom subjected to quantitative feed restriction, especially so in hot climatic conditions.

The weighing procedures for layer breeders would be similar to what is described below for broiler breeders. The only difference is that males are reared with the females and when birds are penned off for weighing sufficient males will not be included and additional penning will be required until sufficient males have been weighed as well. In the order of 150 females need to be weighed irrespective of the flock size and at least 40 males should be weighed to arrive at a good sample weight.

Possible reasons for poor weights and uniformity of layer breeders could include:

- Poor feed and water quality
- Poor chick quality
- Insufficient feed and drinker space
- Feeders and drinkers not operating properly
- Limited water and feed consumption (supply systems)
- Diseased flock
- Extreme high temperature conditions
- High stocking densities
- Poor housing and ventilation conditions
- Varying methods of weighing

If males are underweight at 6 weeks of age, consideration should be given to rear the males separate but not for longer than the first 6 weeks, especially if the sexes are of a different feather colour. Feeding of crumb feed for the first 6 weeks will also assist initial growth, should body weight at 6 weeks be below the breeder guide. However the crumb quality needs to be very good (even in texture and not many large particles). Layer type chicks will not consume large particles.

4.2 Rearing of Broiler Breeders

Most suppliers of broiler breeding stock have developed their own recipes and this text should be read in conjunction with manuals and recipes supplied.

Males and female broiler breeders are to be reared separately because different rates of feeding would apply to the males and females to attain the correct body mass for age. Should this not be possible then separate rearing should be applied for at least the first 6 weeks.

The purpose of rearing broiler breeders is the development of a bird throughout the rearing phase that will result in stock at the point of lay which will have the ability to achieve maximum reproductive performance in the poultry shed as well as in the hatchery. The selection programmes aimed at maximizing broiler performance (rapid growth and feed efficiency) is negatively correlated to reproductive traits and rearing practices to achieve leaner birds at onset of lay must be applied to overcome this. This requires control on feed intake, and as a result a close check on uniformity is required. It serves very little purpose to have a flock with a mean body mass, which is on target, yet with poor uniformity.

4.2.1 Body Weight Control of Broiler Breeders

During the period from day old to sexual maturity the bird goes through different stages of development. In the initial period, development of the immune system, feather growth and development of the skeleton are of most importance. By 6 to 8 weeks of age a "large framed bird" should have been developed and muscle development then becomes important, within the body weight range required. There should be a tendency for the weight gain to accelerate slightly in the period 3 to 10 weeks of age where after it flattens off again. Towards the end of the rearing period, the development of the reproductive system will take place, and body weight increase should again be accelerated from about 15 weeks of age.

Most breeders have developed programmes and body weight for age standards for specific lines. No single recipe is therefore possible. The key points in most field programmes are:

- Stocking density during rearing would depend on the type of building (e.g. natural ventilated or mechanically ventilated) as well as the equipment. It is common to find densities ranging between 7 and 10 birds per m² from 4 to 5 weeks of age after brooding with densities of 14 to 16 birds per m² being applied during brooding
- The feeding system must be capable of distributing feed to all birds as rapidly as possible (under 3 minutes). Should this not be possible in the case of chain feeder systems, the use of a satellite bin half way round the feeding system is to be considered
- Pan and auger feed systems have the advantage that feed is deposited simultaneously into all pans from the auger when the system is activated. Care should be taken to ensure that feed in individual pans is not depleted before all feed has been distributed
- Feed space is critical. As a guide less than 35 days of age (5 weeks) 5 cm per bird, supplemented with chick feeders during the first 10 days, 5 to 10 weeks of age 10 cm per bird and 15 cm per bird thereafter is recommended.
- The feeding of whole grain or pellet feed as a scratch feed is often used to assist in improving the condition of litter. Where this is practised, the rate of scratch feed is in the order of 5 kg per 1000 birds per day and this must be taken into account when calculating feed allocation. This should take place in late afternoon and time thereof should be varied so as to confuse birds of timing thereof.
- Accurate feed weighing is essential. This should apply from the first week as the feed consumed in this period when still on *ad lib*, is used as the basis for determining the feed allocation when feed restriction commences at 3 to 4 weeks of age.
- Always rear males and females separately. Males and females have different requirements for body weight for age profiles and it is not possible to achieve the desired growth curves for both sexes through one system of feeding.

4.2.2 Weighing Procedures

The objective is to rear the flock in such a way that the bird weight for age as per the breed specifications is achieved and that the flock is uniform in body mass. Birds are therefore weighed regularly (weekly) from 4 weeks of age and such weights are compared to the breed standard.

At 1, 2 and 3 weeks of age a sample mass weight is advisable to ensure that the brooding management is allowing chicks to grow normal to the desired weight at 4 weeks of age. With this procedure, chicks are not weighed individually but in mass in boxes or containers and the average weight calculated. Normally the scales used do not allow for accurate weighing of individual birds at such a young age.

From 4 weeks of age, birds are weighed individually to enable calculation of the average weight as well as the flock uniformity by weighing a representative sample of the flock. Some key issues to consider include:

- When weighing birds, the estimated number of birds should be penned off and all of the stock penned off must be weighed. When driving birds into the pens, this should be done gently without frightening and stampeding.
- Select at least three spots for penning the birds and pen off an estimated 50 to 70 birds per pen (150 to 200 birds in total) irrespective of house size. Weigh all the birds that have been penned as smaller birds tend to hide and will normally be the ones that are weighed last.
- The scales used are either 5 kg dial scales with 20 g interval or electronic scales. When using dial scales a weighing sheet as per the example below is used to assist in the calculations that will follow



- The process of bird weighing should occur at the same time on a weekly basis and recorded on weight charts normally provided by the breeding company
- In the case of broiler breeders the body weight guide during rearing is normally on an empty crop so weighing should occur before feeding or on a non-feed day when ship-day feeding is applied.
- Once all weights have been recorded on the chart, the average weight is calculated. This is the sum total of the number of birds within a particular range

multiplied with the weight range and dividing this with the total number of birds weighed.

4.2.3 Weekly Feed Increments for Broiler Breeders

All decisions on feed allocation must be based on the average body mass in relation to the target and accurate body weights are therefore essential. Weekly feed increments should be small (1 to 3 g per bird per day). Should a larger increase be necessary as a result of underweight birds, then spread the increase through the week. Never decrease feed allocation. Rather hold at the same level until target for age is achieved but then again not for excessive periods.

Every day feeding is preferred. Where feed systems are inadequate in terms of feed space being provided, alternate regimes such as skip-a-day in the week, skip two days in the week or alternate day feeding could be considered. It is essential that every day feeding commences again prior to lay (15 to 16 weeks of age) should these alternate regimes have been used.

Make frequent but small adjustments on a weekly basis and should there be doubt re-weigh the birds or start weighing twice weekly to assist in making decisions.

4.2.4 Flock Body Weight Uniformity

The uniformity is calculated by calculating two cut off points, 10% below and 10% above the mean. The number of birds outside these two cut off points are then added and expressed as a percentage of the total number of birds. The aim should be to have at least 75% of the birds within 10% below and above the mean weight. Whilst this does give an indication of the number of birds that are close to the mean, it does not take into account the very heavy and light birds as the calculation of the coefficient of variation would.

Electronic scales are available which record data automatically and the scale calculates the mean mass and uniformity. Some makes of scales are equipped with small printers which will print the individual weights recorded as well as the mean weight and coefficient of variation.

Although more costly as compared to dial scales they are very useful on larger rearing operations as the process is speeded up and data is much more accurate and reliable.

With electronic weighing, the uniformity is calculated mathematically and expressed as coefficient of variation (CV).

$$CV\% = \frac{\text{Standard Deviation} \times 100}{\text{Average weight}}$$

The electronic scale calculates the Standard Deviation. A CV of 9% and lower should be aimed for.

| | Grams | X = One Bird Weight | | | | | | |
|---|-------|---------------------|---|---|---|---|---|---|
| | 1060 | | | | | | | |
| | 1080 | X | | | | | | |
| | 1100 | | | | | | | |
| | 1120 | X | | | | | | |
| | 1140 | X | X | | | | | |
| ▲ | 1160 | | | | | | | |
| | 1180 | X | | | | | | |
| | 1200 | X | X | X | | | | |
| | 1220 | X | X | X | | | | |
| | 1240 | X | X | | | | | |
| | 1260 | X | X | X | X | | | |
| ● | 1280 | X | X | X | X | X | X | X |
| | 1300 | X | X | X | X | X | X | |
| | 1320 | X | X | X | | | | |
| | 1340 | X | X | | | | | |
| | 1360 | X | X | | | | | |
| | 1380 | X | | | | | | |
| ▼ | 1400 | | | | | | | |
| | 1420 | X | | | | | | |
| | 1440 | X | | | | | | |
| | 1460 | | | | | | | |

4.2.5 Grading to Improve Uniformity

Grading of the flock should be done at 4 to 5 weeks. This is done by the creation of separate pens into which birds that differ significantly from the mean of the flock are placed and then fed at a different level of feed so as to improve the uniformity of the entire flock. Normally only the smaller birds would be placed into a "small bird pen". A third pen housing the very large birds may also be considered but this is more difficult to manage, especially when the various pens are on the same feed system.

The cut-off points are determined by weighing a sample of birds in the normal manner. The weight of 10% below the mean weight is then calculated and birds outside (below) this range are placed into a separate pen. Between 10 and 16% of the birds should fall into the smaller pen, depending on the initial flock uniformity. When grading is being done, a scale should be used to distinguish between birds on the border of the weight range.

A practical way to grade the flock is to hold a bird which is close to the cut-off mark in one hand and to compare the feel of such weight to that of a bird on which a decision is to be made. Heavier and light birds are then distinguished much easier and only the birds close to the cut-off point require weighing.

The pen containing the smaller birds is then fed at a higher level so as to improve uniformity of the entire flock. The lighter pen is fed 2 to 3 grams/bird/day more compared to the normal pen until the weight catches up to that of the normal pen.

The object is to gradually get the lighter birds to the weight of the normal pen by 12 weeks of age. Should poor uniformity persist the causes therefore should be investigated and the flock re-graded.

If the pens are on the same feeder system, then allocate feed according to the pen requiring the least amount of feed (normal birds) and add feed by hand to the pens requiring more feed per bird (smaller birds). Ensure that feed and floor space is the same

or slightly more for the underweight birds. The additional feed in the "small bird pen" should be distributed evenly and before the main feeding has been consumed. Where the birds have been penned into normal and light pen weights, weighing of the different pens should be done separately as well as calculations of body weights and uniformity. After grading, bird movement between pens is to be kept to the minimum.

Should the average weight be higher or lower than target, then re-draw a new target for age, starting at the point where the last weight was obtained and ending at the target weight at 20 weeks. Use this then as the new target weight for age. Do not force the birds back to the original weight graph recommendations but rather get them to the weight target over a period of time. Once birds are overweight at say 10 to 12 weeks, a slightly higher than accepted weight at 20 weeks will be acceptable.

Some breeders may recommend out of season flocks (birds that mature during the time of year when natural day length is declining) to be 5% heavier.

The prime objective is to achieve the target body mass for age as recommended by the breeding company and maintain good flock uniformity at all times prior to onset of lay.

No single feed specification can be provided. It is best to seek professional advice but most feed programs will consist of a starter diet to 4 weeks of age, followed by a grower diet to 10 weeks of age and then by a developer diet to 20 weeks of age. The main difference between these diets is the level of amino acids (protein).

4.2.6 Rearing Broiler Breeder Males

Broiler breeder males are to be reared separately as they have very much different body weight for age and feed consumption rate targets compared to females. Each breed has different requirements and it is essential to adjust systems to fit breeder recommendations. The general practices that should apply are similar as explained for the females.

Weigh at least 100 to 150 birds per colony or house and draw two samples per colony/pen. Feed allowance must be adjusted in accordance with body weight for age, making small adjustments as for the females. Feed *ad lib* at least to 4 to 5 weeks of age. Some breeders may recommend a weight selection at this stage to ensure that only the males with the higher potential weight gain are selected for breeding.

Normally 14 to 15 males per 100 females are supplied as a "parent package". By 10 to 12 weeks of age most of the reasons for increased mortality would be past. At this stage the number of males may be reduced to 12% of the female numbers to provide for more floor and feed space for the selected males. This will still allow for some selection at mating.

The aim is a CV of less than 9 % or a uniformity of at least 75% within 10% of the mean mass at mating and a target mass as per the breeder recommendation. Should the 4 to 5 week old weights differ significantly from the normal breeder recommendation then a new target mass for age should be established from this point to the recommended weight at 20 weeks of age. The aim should be to not to make immediate adjustments but to rather do this over time.

Mating should be carried out at 20 weeks of age but not later than 22 weeks of age.

After mating broiler breeder males continue to have different nutritional requirements compared to females and are to be fed at least at different rates if not different feeds, compared to females.

4.2.7 Body Weight and Uniformity Problem Solving

The following key indicators could assist in establishing the possible reason for various problems.

4.2.7.1 Underweight Birds

- Poor feed and water quality
- Poor chick quality
- Insufficient feed and drinker space
- Feeders and drinkers not operating properly
- Limited water consumption
- Insufficient feed intake
- Diseased flock
- Extreme high temperature conditions
- High stocking densities
- Poor housing and ventilation conditions
- Inaccurate and faulty scales

4.2.7.2 Overweight Birds

- Excessive feed intake
- Incorrect nutrition
- Inaccurate and faulty scales

4.2.7.3 Poor Uniformity

- Poor chick quality
- Large variation in Grand Parent flock ages from which chicks are supplied
- Insufficient feed and drinker space
- Irregular adjustment to feed increments
- Feeders and drinkers not operating properly
- Diseased flock
- Poor brooding management
- Poor housing and ventilation conditions

- Varying methods of weighing
- Inaccurate and faulty scales
- High stocking density

4.3 Management during Brooding

The brooding period normally describes the period during which chicks are confined to smaller areas within the building and supplementary heat is being supplied. Certain equipment specially designed for chicks are concentrated within the brooding area.

4.3.1 House Preparation

Although day old chicks carry some parental immunity, the chick has very little resistance to most common diseases. It is essential therefore that the poultry shed has been properly cleaned, disinfected and prepared for the new batch of birds. This will reduce the likelihood of diseases being carried over from the previous flock. This cleaning and disinfecting includes areas such as the ablution and shower facilities to the site as well as removal of all litter and manure from the site.

In floor rearing systems, fresh clean shavings or chopped straw is placed at a depth of 5 to 6 cm after the house has been properly cleaned, disinfected and allowed to dry. Materials used should be absorbent (wood shavings, chopped straw) and not too fine. All equipment is reassembled or dropped from the ceilings and it is essential to ensure that the brooding area has been prepared for the chicks.

All equipment should be serviced and checked after being cleaned and re-assembled. The heaters should be operating before chick placement and house temperature especially that of the floor and bedding should be warm when chicks arrive. Chicks are very easily chilled by a cold floor.

The brooding area is that area to which the day old chicks will be confined, as they require additional heating, different feeders and drinkers and a higher light intensity compared to older birds. Such chick equipment is to be evenly spaced throughout the brooding area.

The size of the brooding area would vary according to the brooding method but as a rule 20 to 30 breeder chicks per m² should be allowed for. With whole house brooding, half the building area could therefore serve as the brooding area by hanging of a curtain in the centre of the building.



Examples of preparing the brooding area

The manner in which the equipment is set out in the brooding area would depend on the brooding method that is to be applied. The objective should be that the feed and drinker equipment is evenly spread and that chicks are kept away from cold areas such as walls.

The brooding area should be warmed prior to arrival of chicks and the heaters and ventilation systems should therefore be operational at least the day before expected chick arrival. Limited quantity of feed is placed on the paper strips (if used) as well as into chick feed pans and the normal feeder system where such feeder system is within the confines of the brooding area. Prior to chick arrival, the drinker system is checked and chick fonts (if used) are filled.

4.3.2 Brooding

4.3.2.1 Chick Placement

It is essential that brooder houses should be well heated prior to chick arrival. Because chicks are poikilotherm (cold blooded) during at least the first week, they lose heat very easily. The floor requires special attention as much heat is lost through the chick's feet. Not only should the bedding be warm but the cement floor as well. The building should therefore be warmed at least 24 hours prior to expected chick arrival.

Chicks should preferably arrive during the morning. This will ensure proper supervision during the initial couple of hours after placement prior to staff going off duty. Upon arrival and during placement the chicks are to be examined for first grade quality thriftiness and mortality in the boxes, commonly referred to as “dead on arrival”.

It is also advisable to check the chick temperature on arrival, especially if chicks have travelled over a long distance. A Braun thermometer is used for this and the tip of the thermometer should be placed into the cloacae. Sample around 100 chicks and should the temperature be below 39°C then consider increasing the brooding temperature for an hour or two to assist in increasing the chick temperature back to normal.



Chick placement and checking chick quality

Sufficient staff should be available for the offloading of chicks and placement in the brooding area as quickly as possible.

Chicks should not remain in closed boxes in heated areas and lids of chick boxes should be removed if chicks cannot be unpacked within a short period of time. Chick boxes are designed to cater for colder environmental condition and chicks could overheat when kept in closed boxes for too long within the stationary chick truck or a heated building.

With nipple systems on floor, chicks should be placed on rough paper below nipple lines. This will ensure that chicks find the nipple drinkers as soon as possible.



Measuring chick temperature with a Braun Thermometer

The chicks are placed by gently tipping the chick boxes and spreading the load evenly over the brooding area. At least a sample of boxes should be counted to verify chick numbers with the hatchery.

Once all chicks have been placed the cardboard boxes are to be burned and returnable baskets and trolleys are returned with the chick truck to the hatchery.

At least a random number of (if not all) boxes should be counted to verify numbers of chicks with the supplier.

The minimum ventilation system should operate and brooder temperature set to operate at the level required for brooding.

The chicks are then left to settle for an hour or two with lights on to ensure that they become accustomed to the new environment. Thereafter a check should be made to see that chicks have easy access to feed and water and that they are remaining within the confined brooding area. The necessary finer adjustment to temperature and ventilation is also done.

4.3.2.2 Chick Quality

First grade chicks

Have no deformities such as skewed beaks, eye or head deformities, etc.

Have properly healed and dry navels

Have a minimum weight of 32 grams (from 52 gram eggs)

Are not dehydrated and craving for water

Stand up well on normal surfaces

Are lively and alert

Are not wet and covered with hatch debris

4.3.2.3 Temperature

The objective during brooding is to get chicks off to a good start and accustom chicks to the normal drinker and feed systems by a gradual increase of the brooding area and a gradual removal of chick feeders and drinkers.

Maximum and minimum brooding temperature at chick level is recorded daily and the thermometer re-adjusted to ensure that a good record is available of what temperature fluctuation occurred within the recording period. A wet bulb thermometer to calculate the relative humidity would also assist.

Should chicks have lost temperature during transport, consider increasing the brooding temperature for an hour or two to get the temperature back to normal. Chicks react like cold blooded animals and are unable to increase metabolic activity to assist in increasing body temperature.

The objective during the brooding period is to

- Achieve normal weight gain as per the breeder guide during the first week.
- Ensure that mortality during the first week is below 0.5% and below 0.75% at 14 days
- Achieve good flock uniformity and even if parent flock is young (producing chicks of 32 to 35 g at day-old) very few chicks should be culled out at 14 days (<0.25%).

Brooding chicks which originate from young parent flocks requires minor adjustment and it is advisable that such chicks are placed in separate brooding areas.

The brooding area is increased gradually until birds have access to the entire building.

During winter the increase in brooding area will be slower than during summer and in open type houses it will be slower compared to closed houses. Feed and drinker equipment should not be limiting in this area. On the other hand, the area should not be increased too rapidly as chicks then tend to "get lost" in the larger house area. This is especially between the outermost chain feeder lines and wall of the building which is normally much colder than towards the middle of the floor area.

House and brooding temperature (maximum and minimum) should be recorded daily and gradually reduced. No fixed rules can be applied but starting at a temperature in the order of 32 to 34°C the aim should be to reduce temperature to around 20 to 22°C by four weeks of age. In open type houses, the temperature close to the brooders is more important than the house temperature and the latter will always be lower than the comfortable brooding temperature. With whole house or partial house brooding, care should be taken not to create very hot and uncomfortable conditions as the chicks cannot escape from the hot area. Chicks should soon be evenly spread over the brooding area and the noise level should signify contentment.

Key indicators to brooding temperature include:

- Chicks that are hot will be noisy, pant with drooping wings and try to move away from heat.
- Chicks that are cold will be noisy and crowd at heat source
- Contented chicks are evenly spread over the brooding area and the noise level should signify contentment

Chick behaviour during brooding should be used to make suitable adjustment to temperature conditions. During brooding the relative humidity in the building should also be a consideration and should preferably be in the order of 55 to 65%.

When chicks originate from young parent flocks (less than 30 weeks of age), special attention should be given to brooding temperature. They are smaller (originate from smaller eggs) and have relatively lower rate of heat production. Such chicks require slightly higher temperature (1 to 2 °C) compared to chicks that originate from older flocks. When these smaller chicks are cold they do not show the normal behaviour of huddling and the indication of them being cold is not so obvious.

They also have the tendency to have been overstressed during the incubation process and extra emphasis should be given to feeding and water supply. They should be brooded separate from chicks that originate from older flocks and if not in separate buildings, at least in separate brooding areas. If not, they will be dominated by the larger chicks and increased mortality and cull rate will result.

4.3.2.4 Feed Management during Brooding

Chicks should have free and easy access to fresh feed at all times. During the initial period, chick feeders and feed on paper is to be replenished regularly (twice daily). The feeders should not be overfilled as this leads to feed soon becoming stale and less palatable to the chicks which will result in reduced feed intake and poor weight gain.

Chick feeders and paper are normally removed after from about 4 to 7 days, depending on the accessibility of the chicks to the normal feeder system. It is essential that chicks

are feeding comfortably from the larger feed system before removal of the chick feeder system and that the feeder pans (and paper if used) are removed over a period of two to three days to encourage chicks to feed from the normal feeder system.

Check weights at the end of the first week are to serve as guide whether feeding and brooding techniques are good. During this period mass weighing is done and the average weight compared to that supplied by the breeder company.

Automated chain feeding systems should be switched on manually at the beginning on a "stop-start" basis to ensure that chicks are not caught up on the chain.

4.3.2.5 Water Management during Brooding

Chicks should have access to clean fresh water at all times. Chick founts are cleaned daily and replenished with fresh water. The water level in Bell drinkers should not be excessively high (half full) as this leads to water spillage. These drinkers are also to be cleaned regularly as there is a tendency for shavings and droppings to land up in these open drinker systems when set low enough for chicks to have easy access to the water. Wet patches should be removed and the cause of leaking systems should be attended to immediately. Chicks that are wet will be uncomfortable and cold.

Nipple and cup drinkers are to be checked for sufficient supply of water and especially in the case of nipple systems, the height of the nipples should be set to ensure that chicks drink with heads in an upward direction but not stretching for the nipple. A 30° angle with the beak is normally recommended by nipple suppliers. With nipple drinker systems water pressure is of extreme importance and supplier recommendations should be incorporated into schedules and checklists that remind staff to make these adjustments timeously.

Where chick founts are used, a change is to be made from such founts to larger drinkers by 7 days of age. When removing chick founts, this should be done over a period of a day or two to accustom chicks to the normal drinker system.

4.3.2.6 Ventilation and Heating

Very often the thermometer reading is not in accordance to the needs of the chickens. When measuring temperature and humidity it must be done as close as possible to chick level but also not right amongst the chicks as the instrument then picks up heat generated by the chicks and a false reading will be obtained. Thermometers are used as guide and it is more important to check the behaviour of the chickens to see if the temperature is correct.

If chickens are evenly spread out and are eating and appearing comfortable and not chirping, then the temperature is correct. However if they form a wide circle away from the heat source then it is too hot. When chicks are crowding in a corner or huddle together, close to the source of heat or even away from the heat source, then it is too cold.

When chickens are exposed to too high or too low temperatures, a condition known as vent pasting could occur. The excrement accumulates around the vent (cloacae) and the condition could become so bad that the chicken is unable to pass urine or faeces, it will

stop eating and will die. Chickens must be able to move closer to and away from the heat source and this is the reason why with whole house brooding, slightly lower temperatures are used as chicks cannot move away from heat should temperatures be marginally high.

It is important to avoid low humidity of the atmosphere during brooding. The ideal is a Relative Humidity (RH) of between 55 and 65%. This will prevent mucous membranes of the respiratory tract from drying out. Dehydration of the chick causes these membranes to dry out and the movement of cilia lining the membranes are retarded. Viruses and bacteria can thus easily penetrate the body.

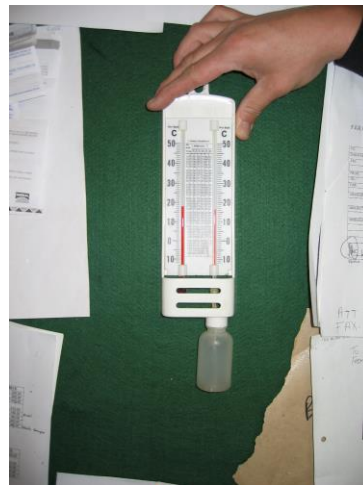
In areas where humidity is normally low, additional water troughs can assist to increase the RH. Gas burners also contribute moisture as opposed to hot water heat exchangers that do not. (The end products of combustion of propane gas are CO_2 and H_2O).

Applying the correct amount of minimum ventilation (not excessive) will also conserve moisture.

During the brooding stage of chick management, ventilation is normally confined to the supply of adequate minimum ventilation. This rate of ventilation must be supplied from the first day within the constraints of maintaining correct house and brooding temperature.

In natural ventilated buildings less control is possible and side curtains or control mechanism are used to control air movement.

In closed houses where ventilation is achieved by mechanical means (fans), there is better control on the fresh air supply into the building and extraction of stale air from the building.



The stack effect of air dynamics is used mainly to control minimum ventilation in open sided buildings. This is achieved by closing side curtains leaving minimum opening at the top of the curtain to allow for some air movement upwards and out of the building. Care should be taken that there is sufficient "leakage" through doors and bottom of the curtain to allow for such air to be replaced from outside.

During brooding the extent of opening the side curtains would be minimal and this will depend on age of birds, outside environmental temperature as well as wind pressure. Chicks should not be subjected to high air movement created by pressure effect of air movement (wind) as they are more susceptible to wind chill, even at normal temperatures. The wind side of the building would therefore be kept more closed than the non-wind side, to reduce direct wind into the building during brooding.

The building should also not be kept completely closed to conserve heat, as this may soon lead to an under ventilated building, even during the brooding period.

A minimum rate of ventilation must be applied, irrespective of temperature. Such minimum rates of ventilation should be described on ventilation schedules and not judged by conditions in the poultry shed only. Once wet litter conditions and high concentrations of ammonia appear as a result of under ventilation (or too cold conditions) it is normally too late to correct.

Schedules on how to set the minimum ventilation should be calculated for the particular application and applied from the first day. These schedules may be calculated from information presented in the **Housing and Ventilation** section of this book.

Air speed over chicks should be kept below 0.5 m/sec. Note that this is not the inlet air speed but the air movement over the chicks. This is especially important in tunnel type ventilation systems.

Incoming air must be diverted away from chicks and distributed as evenly and quickly as possible throughout the brooding area.

4.3.2.7 Key Points during Brooding

Some key points during brooding include:

- Check behaviour of chicks. Cold chicks would tend to huddle while hot chicks will move away from the heat sources
- Chicks should be evenly spread out and quite
- Light intensity to be increased in the first 7 days (above 20 Lux in the brooding). Reduced thereafter to below 5 Lux so as to keep birds calm
- Keep an eye on litter condition, especially once feed restriction commences. Wet litter should be turned or removed if extremely wet
- Adjust feeders and drinkers (height and pressure in the case of nipple drinkers) regularly and remove chick equipment gradually. Get birds onto automatic equipment as soon as possible without undue stress
- Reduce heat gradually from the brooding temperature to the required house temperature of 20 to 25°C at 4 to 5 weeks of age
- The aim is to have a uniform flock by 4 weeks of age with low mortality and body weights that agree to the breeder recommendation.

4.4 Management during Growout

4.4.1 Layer Breeders

The main objective in this period (4 to 18 weeks of age in case of layer breeders) is to achieve the correct body mass for age with high flock uniformity and to prepare the flock for sexual maturity and egg production. Circumstances would differ but some main points include: -

- Weigh birds regularly and endeavour to achieve the breeder recommendations
- Make regular adjustments to equipment such as feeders and drinkers
- Rapid growth takes place between 4 and 8 weeks of age and it is important to ensure that the breed standards are achieved in this period. Skeletal development in this period is of major importance. Daily weight gain decreases in the period 8 to 14 weeks and again starts to accelerate from 14 weeks of age.
- Keep litter dry. Remove any wet areas.
- Maintain correct environmental conditions including temperature and minimum ventilation. It is advisable to have an environmental control programme set up in accordance with particular conditions and house design. Do not guess how to set equipment.
- Keep a close check on bird activity and behaviour
- Follow the recommended light programme and make the required adjustments as and when required
- Follow the recommended feed program and make the changes in feed type as and when required to do so
- Inspect the flock regularly and remove and humanly dispose of birds that are not healthy or growing normally. Very little selection should be done at point of lay and all sexing errors and cull birds should be removed and disposed of humanely as soon as they are noticed
- Ensure that fresh, clean water and feed is available at all times. With feed restriction in broiler breeders, water restriction may be required when using open trough drinkers. Caution should be taken when applying this, especially in hot weather conditions and if applied, a good system of measuring water consumption should be installed
- When making adjustment to feeders and drinkers or any other equipment, do this in a gradual manner so as to allow for birds to adjust to the changing circumstances.

During this period perches are often introduced to train birds to jump onto nests. When applying this practice, ensure that sufficient perch (usually A-frames with 3 rails) for 20% of the flock is placed in female pens at 6 weeks of age (1 per 500 females).

Layer breeders are normally moved to the breeding quarters at 17 to 18 weeks of age.

Keep a record of the flock and make notes so as to assist in building up a history on how to best to manage particular houses and conditions

4.4.2 Broiler Breeders

Broiler breeders especially require close supervision and weighing to ensure correct body weight for age and good uniformity.

Broiler breeder pullets are subjected to feed restriction and more attention to body weight control and uniformity is required. Grading of the female birds is preferably to be done at 4 weeks of age as described above. Control of the body weight for the females should start as early as possible (4 weeks) and as far as possible, the breeder recommendations should be adhered to. Should birds be significantly overweight, then the target mass for age is to be re-drawn from that point to the desired mass at 20 weeks as described above in the section dealing with body weight control and grading. The body mass is not to be reduced or brought back to target in a rapid fashion. Similarly do not overcompensate too rapidly in feed increments, should weights be below target.

If at 10 weeks of age the flock weight is still below or above the target weight then re-draw a new target parallel to the breed standard and apply this as the new guide. At this late stage it is not advisable to force the weight back to standard.

At 15 weeks of age, most breed recommendation would suggest that the weight increment accelerates as the birds prepare for lay and approach sexual maturity. This is the result of physiological development including the development of the reproductive system. In this period more frequent weighing per week (twice) will assist in making correct decisions in feed increments. This situation will continue into the breeder pens.

Broiler breeder males are subjected to even more severe levels of feed restriction but in principle the same as described for the females would apply.

Broiler breeders are moved to the breeder houses at 20 to 21 weeks of age. Males would normally be moved to the breeder houses before the females to ensure that they are accustomed to the building and new systems prior to introducing the females. This could however be problematic in open sided building during winter when the very few males will result in a very cold environment.

4.5 Beak Trimming

Pecking is a normal behaviour of poultry and when housed together in large flocks, especially in open sided buildings where light intensity is high, birds should be beak trimmed so as to reduce the incidence of pecking and cannibalism.

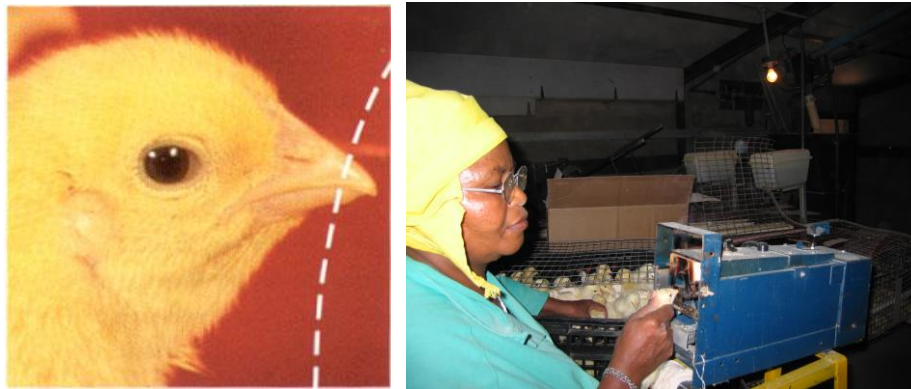
Most breeders would prefer this procedure to be performed at an early age (before 10 days of age) using special hot blade machines with guide plates.

Beak trimming must always be carried out by properly trained staff using well maintained equipment that is specially designed for this procedure and at as young age as possible.

4.5.1 Ten-day Beak Trimming with Hot Blade

Beak trimming is carried out at 6 to 10 days of age using a beak trimmer machine with guide plates and hot blade. The machine is equipped with special guide plates and hot blade for cauterization, which is activated by a switch and moved by means of a camshaft attachment. The cam shaft mechanism allows for the correct time of

cauterisation to occur. Chicks at this age are easier to handle but considerable experience is required and staff performing this should be well trained.



Beak trimming at 7 days of age

The beaks are cut with a sharp hot blade with the beaks inserted into a 0.44-cm hole. The thumb is placed behind the head of the chick with the forefinger placed under the throat, pulling the tongue back and tilting the head downwards. The bottom beak should be slightly longer than the upper beak. The beak is to be kept against the hot blade for a period of 2 seconds and most machines have a timed cam shaft which keeps the blade in the downward position for this length of time.

Approximately one third of the beak measured from the front of the nostril is removed. This would however depend on the breed as some breeds may require a more severe beak trimming compared to others. The objective should be to remove as little as possible keeping in mind the effect on pecking and cannibalism. Males are normally trimmed less than females and for broiler breeder males, the beaks are often just tipped.

Key points are:

- Keep a steady rate and do not rush
- Blade must be hot. Most suppliers of machines recommend the blade to be a “cherry red” colour
- Keep guide holes clean with a brush and replace the guide plate from time to time
- Blade must be sharp. Replace after every 3000 chicks. Note that different blades are used for early and later beak trimming and ensure that the correct blades are being used
- Always maintain the same procedure and make adjustments in accordance with what observations are made later during the layer stage. Beaks must be rounded and there should be no sharp points on the beak

A second method is to apply beak trimming at 4 to 6 weeks of age. This is a much slower process as birds are more difficult to handle but a more precise cut is obtained, as there is a larger area by which the length of the beak remaining may be judged. The same machine is used as for 7 day beak trimming but a bar, onto which the blade cuts, replaces the guide plate. The blade would also be different.

The thumb is placed behind the head and the forefinger inserted into the mouth so as to open the beak. The upper beak is then placed on the bar with the head being tilted downwards so as to obtain a cut towards the inside of the beak. The hot blade is pressed downward, cutting and cauterizing the cut for a period of 2 seconds. After cutting the upper beak, the lower beak is placed onto the bar and cut at a length slightly longer than the upper beak (1mm longer).

The length of the cut will depend on conditions and generally one would cut as much as may be required so as not to experience problems in the breeding period. This is usually achieved by removing no more than one third of the upper beak. Broiler breeders are usually trimmed at a longer length than layers breeders. Males are also often cut at a much longer length than females.

From a welfare point of view the early beak trimming at 10 days is preferred as this is considered to be less stressful to the chicks.

Some key points in solving problems include:

- Soft beaks cut back to close to the nostril is caused by blades being too hot (over cauterized) or the beak being cut too short (guide hole too large for the size of chick). Consider changing the age of beak trimming.
- Split beaks are caused by blunt blades
- Beaks not rounded and showing signs of pointed growth are caused by the cut not being short enough and blade possibly being too cold. Cauterizing time could also be too short
- Bottom beak shorter than upper beak is caused by head being tilted too far with 6 to 10 day beak trimming or cut and cauterized too much with beak trimming at a later stage
- When the bottom beak tends to grow out much longer than the top beak, then the head was not tilted enough at 6 to 10 day beak trimming or not cut and cauterized enough with beak trimming at a later stage.

4.5.2 Infrared Beak Trimming

Hatcheries are increasingly making use of day-old beak trimming with the infrared beak trimming machine. Traditional beak trimming with a hot blade cuts off approximately one third of the upper and lower beak and cauterization seals the blood vessels and prevents bleeding. Infrared beak trimming results in heat coagulation in the tissue culture and the necrosis involves about 1/3 of the upper beak and 1/4 of the lower beak in chicks. An important welfare advantage of this method is that research has shown that no neuromas develop, which are relevant in connection with phantom pain after amputation.

With infrared beak trimming at the hatchery the beak is morphologically left intact until the dead tissue drops off at around two weeks of age and a further advantage is that the beak treatment machine is fitted to carry out Mareks vaccination as well. An additional handling on the rearing farm to carry out the 10-day beak trimming is eliminated and chicks do not undergo the stress of the beak treatment at 10 days.

Many hatcheries are offering this procedure and it is preferred by those involved in the welfare of poultry.

4.6 Morphological Alteration of Chicks

4.6.1 Dubbing of Males

Some breeds of males are very aggressive and tend to fight causing damage to large combs. To overcome this, males may be dubbed at day old by cutting the comb with a sharp rounded scissors as close to the head as possible. It should however only be done as a last resort.



Dubbing a day old male chick

4.6.2 Toe Nail Cutting of Males

With some breeds the females could be injured unduly by the males during mating. This may be partly overcome by cutting and cauterizing the back toe normally used by the male to grip the female behind the wings during mating. In severe instances of damage, the inner toe may also be cut but this should only be considered once all other possible causes of female damage have been investigated.



Toe nail cutting and de-spurring of male chicks

The toe is cut and cauterized just behind the nail at the first joint. Special hand held machines are used for this purpose but the beak trimming machine explained above for beak trimming at 4 to 6 weeks of age could also be used.

4.6.3 De-spurring of Males

The spurs of males could also result in injury to females as well as males damaging one another during fighting. To overcome this, males are de-spurred.

This task is also performed at day old using a special hand held machine, very much like a sharp electric soldering iron, and touching the spur knob with the hot point. Again staff should be very trained in the procedure and this only be applied as a last resort to eliminate injury to females.

4.7 Management of Layer Breeders

The production of quality hatching eggs starts with good flock management.

4.7.1 Flock Placement and Mating Ratios

Layer breeders are normally housed in the breeder houses at 17 to 18 weeks of age and in most cases an all litter floor system is used although partially slatted floor houses are becoming more popular. In “day old to death” systems, it is essential that nest boxes are placed in the poultry sheds by 18 weeks of age. The same practice in relation to house preparation as suggested in the rearing of the birds explained above will apply. Houses should have been appropriately cleaned and disinfected and prepared for the new birds, well in advance of the flock being transferred.

Birds are to be handled gently and caught by both legs when placing them into or removing them from crates.

The mating ratio would depend on the breed but is usually between 8 and 10 females per male. With light breeds such as Leghorns it could even be higher at 12 hens per male (8%). With layer breeders the sexes are normally reared together and getting males used to more dominant females does usually not pose a problem.



4.7.2 Selection of Females for Breeding

Throughout the rearing period a process of culling has occurred so that by 18 weeks most obvious inferior birds have already been removed from the flock. At transfer more attention is given to less obvious body abnormalities, like beaks that are skew, twisted necks and leg and toe deformities. Pullets that are obviously small and sexually immature should also be removed.

In the selection of females for breeding purposes all of the birds are to be individually handled and the following birds removed:

- Under developed and immature birds (comb size and body development)
- Very light birds
- Birds with crooked legs (bandy) and toes (curled inwards)
- Birds with any skeletal defect (crooked back or breast bone)
- Birds with abnormal beaks after beak trimming
- Birds with rough feathers
- Birds with no tail feathers
- Birds that show appearance of possibly being a male
- Birds not showing the normal feather plumage of the breed in question

This is done by firmly holding the bird with one hand supporting the bird below the abdominal area with one leg between the thumb and first finger and the second leg between the third finger and the pinky with the bird facing towards you. This hand is then used to feel the keel bone and breast muscle whilst holding the bird by the wings with the other hand. The fingers feel for the two pubic bones at the cloacae, which should start to move apart in birds approaching sexual maturity. Birds in full lay should enable three fingers between the pubic bones. Supporting the bird below the abdominal area then also leaves the second hand to turn the head for inspection of the face and comb areas as well as inspection of toes and legs and feeling of the feathers.

4.7.3 Selection of Males for Breeding

More strict selection is applied on the males and each male is to be handled individually. In layer breeders very heavy and very light males should preferably not be used for breeding purposes. A ratio of 9 to 10 males for every 100 females is used when transferring birds.

Handle each male individually in the same manner as explained for females above and birds with any abnormalities removed.

- Under developed and immature birds (comb size and body development)
- Very light birds (this will be determined by the weight range selected for)
- Very heavy birds
- Birds with crooked legs (bandy) and toes (curled inwards)
- Birds with any skeletal defect (crooked back or breast bone)
- Birds with abnormal beaks after beak trimming
- Birds with very rough feathers
- Birds that show appearance of possibly being a female

Males should appear bold and have a strong upright stance when placed on the ground.

Selected males should be free of any physical abnormalities, have strong straight legs and toes, be well feathered and have a good upright stance. The secondary sexual characteristics (face and comb colour as well as wattle and comb growth) should indicate that the birds are equally advanced in sexual maturity compared to the females.

When males are placed into the laying house they are to once again check for any physical defects and should any defect have been overlooked or missed during the initial selection process, the bird should be removed. It is a good practice to inspect the males

when they walk away when placed. This is the time to finally notice any leg defects, especially bandy legs.

4.7.4 Adapting the Flock to the New Environment

The greatest single problem is to get birds accustomed to the nests so as to reduce the incidence of floor eggs. In layer type breeders it is normal to allow 4 birds per nest opening. Nests are normally started at a low setting, close to the floor to encourage birds to use the nests. They must be kept clean from the outset, even though hatching eggs may only be kept from a later point in time.

Floor eggs are to be removed regularly and birds discouraged from laying eggs in corners. Do not place nests in corners, as this will encourage birds to move to the corners resulting in overcrowding of these nests. This is a greater problem in more modern automatic nests, which cannot be adjusted. The use of perches during rearing will also assist in teaching birds to jump onto nests. Keep nests away from direct sun.

4.7.5 Routine Flock Management

Routine flock management will include feeding an appropriate breeder ration *ad lib*, routine cleaning of drinker systems and collection of eggs. The management practices in relation to hatching egg quality are explained elsewhere. Care should also be taken to ensure that vices such, as pecking does not get out of hand. In some breeds females are especially dominant and males are constantly being pecked resulting in high mortality or peck-out. More severe beak trimming could be considered as well as the elimination of sunlight. The use of black tar on affected birds could be considered.

The use of scratch feed such as whole grain or pelleted feed in the afternoons could be considered to encourage male activity and exercise.

4.8 Management of Broiler Breeders

Most breeders have their own set of management guides, especially in relation to weight gains in the period 15 to 24 weeks of age. The basic principle is that this is the stage during which the bird is undergoing much physiological change and inadequate nutrition and feeding could result in permanent damage to the flock. Body mass gain is usually accelerated at this point irrespective of the actual mass in relation to the target. Prior to 15 - 16 weeks of age, feed allocation could have been reasonably stable but from this point in time, it is essential that feed levels increase steadily. From this point, every day feeding must be practised as individual birds are changing at a rapid pace. Birds should also not become overweight, undoing the work prior to this point. It is therefore critical that body weights are accurate and that the breeder recommendations are followed meticulously. More frequent weighing (twice weekly) should be considered during this period if response to feed increments is uncertain.

4.8.1 Placement of the Flock

Mating up should take place at 20 to 21 weeks of age, which is the point at which birds are moved to the breeder houses. A stocking density of 4 to 6 birds per m² is usually applied in well ventilated houses all litter houses. In slatted floor houses stocking density could be increased by 10%.

Mating ratio could vary according to the breed but is usually in the order of 10 females per male. It is advisable to transfer the males to the breeder a day or two prior to the females being transferred. However under cold winter conditions in open houses care should be taken that the house is not too cold.

The males transferred should have good uniformity and body weight, they should have no physical abnormalities, have strong and straight legs and have a sound upright stance. Males should be equally sexually advanced and have sound sexual characteristics (facial development, comb colour and wattle development).

4.8.2 Selection of Females for Breeding

Throughout the rearing period a process of culling should have occurred so that by 20 weeks most obvious inferior birds have already been removed. At transfer more attention is given to less obvious body abnormalities, like beaks that are skew, twisted necks and leg and toe deformities. Pullets that are obviously small and sexually immature should also be culled out.



In the selection of females for breeding purposes all of the birds are to be individually handled and the following birds removed:

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- Birds not showing the normal feather plumage of the breed in question

This is done by firmly holding the bird with one hand supporting the bird below the abdominal area with one leg between the thumb and first finger and the second leg between the third finger and the pinky with the bird facing towards you. This hand is then used to feel the keel bone and breast muscle whilst holding the bird by the wings with the other hand. The fingers feel for the two pubic bones at the cloacae, which should start to move apart in birds approaching sexual maturity. Birds in full lay should enable three fingers between the pubic bones. Supporting the bird below the abdominal

area then also leaves the second hand to turn the head for inspection of the face and comb areas as well as inspection of toes and legs and feeling of the feathers.

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Selected males should be free of any physical abnormalities, have strong straight legs and toes, be well feathered and have a good upright stance. The secondary sexual characteristics (face and comb colour as well as wattle and comb growth) should indicate that the birds are equally advanced in uniformity and sexual maturity compared to the females.

Handle each male individually and birds with any abnormalities are removed.

- Under developed and immature birds (comb size and body development)
- Very light birds
- Birds with crooked legs (bandy) and toes (curled inwards)
- Birds with any skeletal defect (crooked back or breast bone)
- Birds with abnormal beaks after beak trimming
- Birds with very rough feathers
- Birds that show appearance of possibly being a female



Males should appear bold and have a strong upright stance when placed on the ground

When males are placed into the laying house they are to once again be checked for any physical defects and removed should any defect have been overlooked or missed during the initial selection process. It is a good practice to inspect the males when they walk away when placed. This is the time to finally notice any leg defects, especially bandy legs.

4.8.4 Feed Management

Control of feed allocation continues through the breeding stage and the modern practice is to feed males at different rates compared to females. This is achieved by separate sex feeding equipment which is usually a grid over the feed trough which is small enough not to allow the males to get their heads through whilst the male feeders are the set at a

height that the females cannot reach. The width between the grids is in the order of 43 mm wide and 50 to 55 high with A-frame grids fitted onto chain feeders. A flat plank can also be placed on the feed trough with a 45-mm gap between the trough and the plank. With pan feeder systems a grid over the pan allows females access to the feeder but stops males from feeding from this system.

Feed space is critical and all birds should be able to feed at the same time. A minimum of 15 cm of single sided trough (7.5 linear m per 100) per female should be allowed (or 12 X 40 cm pan feeders per 100 females) and 18 cm per male (15 x 40 cm pan feeders per 100 males). The height at which the male feeders are set would depend on the breed but they must be set at such a height that females are denied access (50 to 60 cm).



Separate sex feeding of broiler breeders

At the point of housing the flock, many of the males will still be able to feed from the female feeders. For a week or two the flock will therefore be treated as one and females should be allowed to use the male feeders. Once most males are feeding from the male feeders (unable to feed from the female feeders) the male feeders are then lifted to a height enabling only the males to feed from them. Very close and daily supervision is required at this stage.

To enable feed to be distributed as quickly as possible throughout the house, high-speed chain feeders are used (18 meter per minute). With long houses, an additional hopper will be placed at the opposite end to keep returning feed track filled. With pan feeder systems the feed in the auger pipe between pans will allow for feed to be placed in all pans almost simultaneously. But then again the system should not be too long so as to allow for the system to be filled before this smaller amount of feed is consumed from the pans. Poor and slow feed distribution will result in uneven feed consumption by the flock and poor performance, as dominant birds will consume more feed. Feeders should be activated just after the lights are switched on in the morning. Feed should not be fed when the birds are in the nests laying eggs as this will result in increased floor eggs. Male feeders are activated only once the female feeder has been filled and all females are feeding.

In the 20 to 30 week period, females should continue to grow at the required rate. The increase in feed allocation goes hand in hand with the increased stimulation obtained with the light program. It is essential that the breeder's recommendation is followed and minor adjustments made to suite local conditions. The combination of the correct light

and feed stimulation will ensure the correct age at maturity (onset of production) and egg size. Breed standards would vary but most broiler breeders would commence production at about 23 to 24 weeks of age, peak at 28 to 30 weeks of age and show a gradual decline in production to roughly 50 percent at 60 weeks of age. The maximum feed allocation is to be reached when the daily flock production is in the order of 60 to 70%.

After 210 to 217 days of age (30 to 32 weeks), weight gain is mostly through fat deposition and in broiler breeders this should be controlled. Peak egg production should occur at about 30 weeks of age for most breeds and peak egg mass output (production x egg mass) occurs 2 to 3 weeks later. Feed allocation should therefore be reduced after this point has been reached to eliminate the chance of over feeding the females. This is achieved by reducing the amount of feed allocation to achieve a continued weight gain in the order of 15 gram per bird per week.

The rate of reduction in feed allocation would depend on: -

- Composition of the diet
- Environmental conditions (temperature)
- Flock history.

The main principle is to gradually reduce the amount of feed from the peak level of around 170 to 175 gram per bird per day (starting at 30 to 32 weeks of age after peak production has been reached) to the expected level of 140 to 145 grams per bird per day at depletion. This reduction is accelerated in the period 30 to 40 weeks of age and 50% of the expected reduction is to occur in this period.

The balance is then reduced over the remaining 20-week period. This is to serve as guides only and flock histories, production performance, egg weight as well as body weight, together with breeder recommendations are to be considered in making final decisions.

The feed allocation for broiler breeder males will also accelerate in the period leading up to full mating activity at around 26 to 27 weeks of age when feed intake consumption in the order of 130 to 135 g per day is reached. Here again breeder recommendations and feed formulation should be considered.

Some basic key issues include:

- Males should continue to gain in weight in accordance with breeder standards
- An allocation of 130 to 135 g should be reached at peak mating (26 to 27 weeks of age)
- Thereafter increased allocation would depend on season as well as body weight of the birds. - Increments in the order of 4 to 5 g every month to a maximum of 145 g to 150 g would be normal
- Continue to weigh a sample of males. More frequent during the period 20 to 32 weeks of age and at least monthly thereafter.
- Males should never lose weight but should also not gain weight in excess of breeder recommendations.

4.8.5 Routine Flock Management

Observe the behaviour of the flock continuously and note any diversion from the normal

- Males that are working are active and have a very red vent colour and red streaking on the legs
- Weigh the flock regularly (weekly) and make small adjustments as necessary
- Follow the recommendations of the breeder and make notes and adjust to suite local conditions. Do not “re-invent the wheel”. Depending on the environment, maximum feed allocation (170 to 175 g per bird per day) should be reached at 60 to 70 percent production. Extreme cold conditions could call for higher rates of feed allocation. Do not increase beyond this point as this could lead to overweight birds
- Ensure that males are not feeding from female feeders and vice versa
- Feed and light stimulation go hand in hand
- The change to the breeder ration should be at 20 to 22 weeks of age
- From 5 to 10 percent production note and support the required increase in egg mass with the feed and light stimulation. It is advantageous to weigh eggs and compare to breed standards, as this measure will also reflect adequate feed allocation.
- It is not recommended that feed allocation be increased beyond the point reached at 75 percent production as the response to egg weight fades at this point and maximum body mass is then approached

4.9 Light Programs for Breeders

Light intensity, the length of the daily light period and the pattern of daily change, produce biological responses associated with sexual maturity and egg production. These responses are as a result of the effect of light on the activity of the anterior lobe of the pituitary gland, located at the base of the brain and the production of hormones that in turn affect the development and production of hormones in the reproductive systems of the birds.

4.9.1 Physiology of the Effect of Light

Photoreceptors in the hypothalamus are the biological transducers that convert electromagnetic signals received from the eye into a hormonal message through their effect on the hypothalamic neurons that secrete Gonadotrophin Releasing Hormone (GnRH). GnRH is secreted into the hypothalamic portal system and transported to the pituitary gonadotropes of the pituitary gland.

The gonadotropes respond to this stimulation by producing Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH). These hormones are secreted into the circulatory system and they in turn activate the ovaries in the female to produce hormones androgen, estrogens and progesterone while in the male they stimulate the testes to produce the hormones androgen and testosterone.

Light programmes are used to control the age of sexual maturity of poultry stock and are important tools in managing breeder birds. In principle decreasing the day length (photoperiod) during rearing will increase (delay) the age at sexual maturity and

increasing the photoperiod during rearing will decrease (enhance) the age at sexual maturity.

Age at sexual maturity is influenced by:

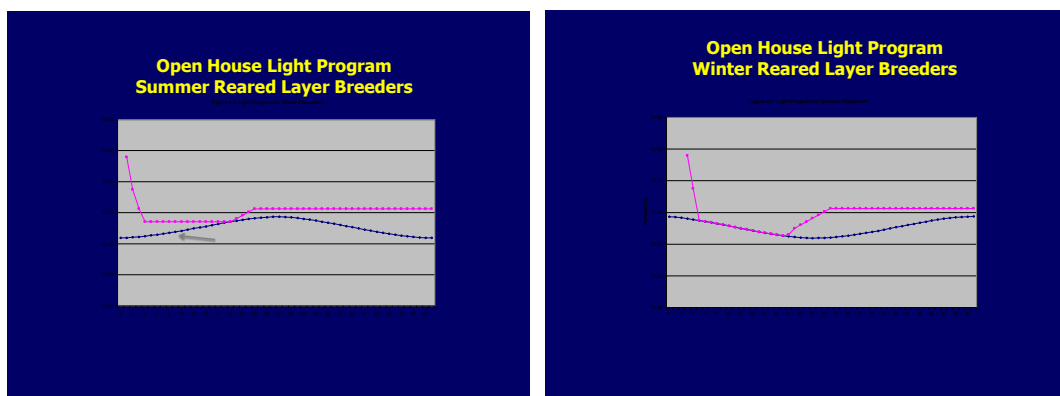
- The photoperiod (length of day) as well as the changes in photoperiod to which the birds have been subjected to during rearing
- Constant photoperiods during rearing less than 10 hours will delay maturity compared to longer constant photoperiods
- A reduction in photoperiod during rearing will delay maturity and an increase will enhance sexual maturity
- Some breeds and genotypes are later (or earlier) maturing than others
- Within a genotype, lighter birds will be delayed in maturity

Much research has been conducted on the effects of various light programs on poultry and breeders and suppliers of stock have developed programs and recipes to suite particular circumstances. No single program can be prescribed for all circumstances as the ideal age of sexual maturity may differ as a result of the effect on overall production and egg weight.

With broiler breeders especially, the light program should be developed together with the feed and body weight control program.

4.9.2 Light Programs for Open Rearing Houses

In open type rearing houses the light programme will take cognizance of the varying natural day length and will be set up in such a manner that the total light (natural and artificial) never increases during the rearing period. A combination of creating a constant photoperiod by adding a period of artificial light to the natural photoperiod or using the natural declining photoperiod will be followed, depending on the time of year as is indicated in the examples for a spring and autumn reared flocks, starting with 23 hours for the first week.



Examples of light programs for open houses rearing to overcome the effect of an increasing photoperiod

The basic principle in such houses is to use the shorter day length in winter as well as the declining photoperiod to delay maturity. During periods of increasing and longer day

lengths (spring and summer), a constant photo period will be used to overcome the effect of the increasing day lengths by adding artificial light. When flocks are placed at a time when the natural day length will be both declining and increasing in the 17 week period, for example chicks placed in May and maturing in August, a constant photoperiod will be used which will be based on the longest natural day in the 17 weeks.

With open house rearing, it is not possible ensure a constant age at sexual maturity for all flocks throughout the year. Flocks reared during autumn will be delayed in maturity compared to flocks reared in the spring.

Prior to the expected onset of production the photoperiod is increased. For layer breeders this is normally at 17 to 18 weeks of age and for broiler breeders at 20 to 21 weeks of age when feed increments are also increased.

The increased steps to be applied at this point may differ from breed to breed.

For layer breeders, increases in the order of 30 minutes to 1 hour per week to a maximum of 15 hours will suffice. Birds reaching sexual maturity during the winter months will have a longer period over which this stimulation is possible compared to summer maturing flocks, when the 15 hours maximum photoperiod will be reached rather soon.

For broiler breeders open house rearing does present problems in that there is limitation in the light stimulation in summer maturing flocks. For such flocks the increased photoperiod will be an initial stimulation of at least one hour and holding the second stimulation back for a week or two. For winter maturing broiler breeder flocks, the initial stimulation will also be at least one hour and stimulation thereafter would depend on the remaining hours available. Generally, most breeders would recommend increments of at least one hour every week.

The total photoperiod provided should be longer than the longest day within the laying cycle, which in South Africa would be in the order of 15 to 16 hours. It serves very little purpose to provide for longer photoperiod which is sufficient to provide for twilight periods as well. Broiler breeders may however increase to 17 hours in order to have more scope for increased in photoperiod in flocks maturing in summer.

4.9.3 Photorefractoriness in Broiler Breeders

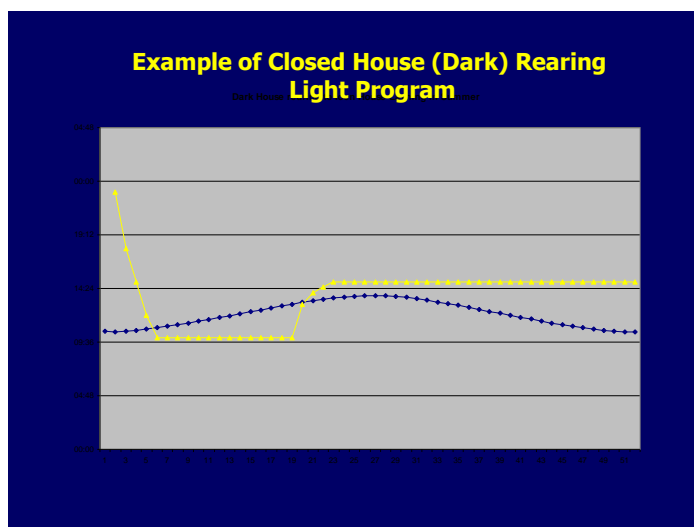
Photorefractoriness is the inability of broiler breeders to respond to an otherwise stimulatory day length. Broiler breeders should preferably be reared in closed (dark) houses. Where this is not possible most breeders are currently recommending that when rearing broiler breeders in open sided buildings, natural day light should be applied during rearing. Research at the University of Natal questions the correctness of applying a constant “long day” to broiler breeders when they would otherwise be exposed to a natural increasing day length. Sexual maturity is markedly delayed when broiler breeders are maintained on day lengths that are longer than 11 hours during the rearing period.

4.9.4 Light Programs for Dark Houses

In dark houses, the programs would normally start off with 23 hours light and 1-hour darkness so as to get chicks used to the environment and off to a good start and to

accustom them to darkness as well. From 7 days of age the light period will be reduced in weekly steps down to 10 or 8 hours at 4 to 6 weeks of age. Eight hour light and 16 hour darkness will generally delay sexual maturity compared to 10 hours light and 14 hours darkness whilst the longer the period taken in getting down to this level from 1 week of age will also delay sexual maturity more than a quicker period of time. More detail discussion is presented in the Environmental Control of the book Housing and Equipment.

Dark house light programs provide for better control on the sexual maturity of the stock and although some slight seasonal variation may still occur, it is much less compared to pullets reared pullets in open houses. A typical dark house rearing program is presented in below.



When moving birds to open breeder houses, the light program will increase to natural day length when this is longer than 12 to 13 hours and at least by 1 hour, when natural day length is less than 13 hours in the case of layer breeders and 2 hours in the case of broiler breeders.

Thereafter for layer breeders, 30 minute increases per week are given. In summer the increase to maximum will be reached fairly quickly and the subsequent stimulation following the initial stimulation may be held back for a week or two. In winter the stimulation will be over a longer period, reaching maximum by 24 to 26 weeks of age.

For broiler breeders, the increased photoperiod per week recommended by most breeders are 1 hour increments following the initial two hour stimulation. For flocks maturing in summer when the initial stimulation is rather high, the second stimulation may be held back for a week or two.

When birds are housed in breeder houses where natural day light is excluded (dark houses), the light program following rearing is controlled, compared to when birds are transferred to open laying houses. In such laying houses the natural seasonal changing day length has no influence on the birds.

With such conditions the photoperiod will be increased by one hour steps from the 8 hour constant photoperiod during rearing to a maximum of 13 to 14 hours in the case of layer breeders. There is no benefit in increasing the photoperiod beyond this point. Depending on the rate of decline during the first three to six weeks of rearing, the onset of production may be delayed or enhanced to suite requirements.

For broiler breeders the initial stimulation will be in the order of two to three hours followed by 1 hour increments thereafter. Most suppliers of broiler breeders will recommend 16 hours as the maximum photoperiod reached.

4.9.5 Light Intensity

Chicks require high light intensity (20 lux) to ensure that feeders and drinkers are found easily. During rearing the light intensity is reduced to keep birds calm and reduce pecking. A light intensity of around 5 lux is normal during the rearing.

Although work done by Morris as early as 1967 in Reading (England) showed that there is evidence of a 5 lux threshold to sustain maximum production in layers in dark houses, layers and layer breeders in open houses are normally supplied with higher light intensity (10 to 20 Lux) because poultry houses are full of equipment creating shadows that reduce light intensity. Light bulbs also pick up dust, which reduces the light intensity of the bulb.

In the case of broiler breeders, there is evidence that a 10:1 ratio is required to distinguish day from night and consequently to initiate a maximum photoperiod response in open houses, broiler breeding stock require the artificial light intensity level to be in excess of 50 lux. In completely dark houses, where natural day light has no influence, a light intensity of around 30 lux will be sufficient to maintain satisfactory levels of production.

Some key issues in ensuring the correct light intensity include: -

- Do not decrease light intensity during the breeder period
- Keep light bulbs clean
- The further the object moves away from the light source the lower the intensity.
- Do not expose birds to direct sunlight
- Replace faulty lamps regularly
- Measure light intensity on the floor at a point furthest away from the light source, which would be between two light bulbs.

5 Hatching Egg Quality

Good hatchability and chick quality is of vital importance in the process of day old chick production. The quality of hatching eggs plays an important role in this. Poor handling of hatching eggs in the period prior to being set in hatching machines will influence the ability of the hatchery to produce quality chicks. Various aspects in the handling of such eggs need close management control.

Maintaining good hatching egg quality starts with nest management. Apart from ensuring sufficient nest box space (4 to 5 females per nesting hole in conventional nest boxes), the day to day management of such nests and keeping the nest material clean is important. The nest material is continually being spoiled by eggs that are broken in the nests, manure being carried into the nests by the hens as well as birds sleeping in the nests.

5.1 Nest Management

Soiled nesting material should be continually removed and replaced or topped up with clean material. It is a good practice to replace all material from time to time (every second to fourth week).

Various nest materials are used including shavings and chopped straw. The important factor is that the material should be clean, dry, not dusty and be able to absorb moisture. Should the material be very fine, it will adhere to the wet egg after being laid and such material is often difficult to remove. Synthetic material (Astroturf) which can be removed and cleaned is also used, especially in automated nests.



Example of poor nest management on the right

5.1.1 Training Birds to Use Nests

Birds should be trained to use the nests and different breeds react differently. Various practices could be suggested to assist in teaching birds to lay eggs in the nests rather than on the floor.

- Nests should be in the house prior to the birds being placed in the breeder pens.
- Start nest as low as possible, especially with broiler breeders.
- Keep nesting material clean and fresh from the start.
- Ensure that nests are well ventilated but not draughty.
- Positioned nests so that openings face away from direct light and air movement
- Pick up floor eggs regularly. This is of extreme importance when birds commence production. In the initial stages, such eggs may be placed in the nests so as to encourage birds to use the nests.
- Try to eliminate corners and nesting areas below equipment such as feed hoppers and the nests themselves.
- Do not place nests in corners as this encourages birds to concentrate on these nests.
- Spread the nests as evenly as possible.
- Supply sufficient nest space from the start.
- Place drinker lines adjacent to nests.

5.1.2 Automated Nests

Automated nest need to be placed in such a manner that the collection system will run down the length of the row of nests. This creates a barrier in the house and the house is then usually divided into two sections over the length of the building. Such automated nests can be individual nesting holes but the trend is towards communal nests. The eggs roll out to the front or to the centre of two back-to-back nests. Variation to the basic system exist and include a tilting Astroturf floor, which serves to remove dust and dirt when tilted as well as closing the nest at night.



Individual Chorettime nest left and Big Dutchman colony nests right

As a result of the positioning of automated nests, as well as the fact that the height cannot be altered, it is more difficult to teach birds to use such nests especially in all-litter houses. Such nests are more common in slatted floor breeding houses where feeding and water systems are placed on the slatted floor area with the drinker systems close to the nest openings and the birds are so attracted to move towards the nests. A litter area encourages dust bathing and mating activity, especially when scratch feed is used in afternoons.

Where automated nests are used in all-litter houses, placement of drinker lines close to the nest openings will assist in encouraging birds to use the nests.

5.1.3 Broodiness

Although the tendency towards broodiness has to a large degree been eliminated through genetic selection against this trait, it may still develop in some breeds. When left in the breeding house these birds occupy nests and sit on eggs. This leads to nest as well as egg contamination and the nests are not available for other birds.

Should broodiness become a problem, the causes thereof should be investigated which in most instances is due to infrequent egg collection and breed.

5.2 Egg Collection

Hatching eggs should be collected and removed from the nests as many times during the day as is practically possible but not less than twice per day. With normal light programs most of the egg production will occur early morning (before 9 am) and less production occurs later during the day. Not many eggs will be produced after 2 pm.

5.2.1 Manual Systems

In manual systems eggs should be collected from the nests at least twice per day. This should be increased in times of extreme temperature conditions (hot and low temperatures) as well as when the flock is in peak production and nests are being used more often. When eggs are left in the nests they are being pre-incubated by the hens sitting on them and bacterial contamination is increased. It is also important to collect all eggs produced during the day and not to allow eggs to remain in the nests overnight. This is of special importance during weekends. Production is at a peak during the early morning, especially when production commences. Collection of eggs from nests in the morning should therefore receive priority.

Eggs are placed on the trays round ends up as the air cell is in this end of the egg. The blastoderm will also move towards this end during storage. During the collection process only clean good quality eggs are placed on the collection trays. Soiled and eggs that are not considered to be hatching eggs are to be placed on separate trays during the collection process. Time spent in collection of eggs will eliminate the need to re-grade and re-handle eggs at a later stage. Do not remove manure or attempt to clean the nests whilst collecting eggs as this will contaminate the hands which in turn contaminates clean eggs being removed as hatching eggs. It is advisable to wash hands before collection of nest eggs commences.

5.2.2 Automated Systems

With automated or roll away systems the frequency of collection is less important as eggs roll away from the birds and these nests are generally much cleaner. Eggs should however be removed at least twice per day, normally during the morning and again in the afternoon after production to ensure that limited numbers remain in the system overnight.

With automated systems the eggs are transported by egg belts to the one end of the poultry shed, where they are collected and placed on the setter trays or pulp or plastic key trays. Belt cleaners and sanitizers are to be installed to ensure that belts are dry and clean when eggs are collected.

Only good clean hatching eggs are placed round end up onto the egg trays and eggs that are considered not to be hatching eggs are placed onto separate trays.

It is advisable to wash hands before collection of nest eggs commences.

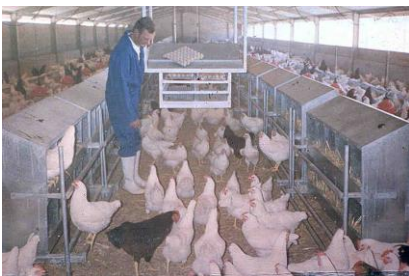
5.2.3 Collecting Floor Eggs

Floor eggs should be collected and removed as regularly as possible, especially during the early morning. This is of special importance when production commences and birds are being trained to use nests.

These eggs have been lying in a dirty area and are contaminated with litter and faeces. It is also advisable to wash hands after collection of floor eggs. Floor eggs are not considered to be clean hatching eggs and should be kept separated from clean nest eggs at all times.

5.2.4 On Farm Traying of Eggs

In integrated operations, eggs could be collected direct onto setter trays as opposed to pulp or plastic key trays and placed onto egg trolleys for transporting to the egg room and hatchery. This eliminates double handling but does slow down the collection process, as more strict selection of eggs must be done in the poultry shed during collection.



Example of a monorail

When on farm traying is practised, care should be taken in sanitizing setter trays and trolleys prior to being returned from the hatchery. Should this not be done with extreme care it could serve as source of cross contamination of diseases and breaking down of the biosecurity measures.

When using pulp trays, it is preferable to use such trays once only as they cannot be sanitized properly prior to being returned to the breeder farm. Pulp trays are also not suitable when fumigating eggs as the pulp will absorb the formaldehyde gas.

5.2.5 Washing of Hatching Eggs

Washing of hatching eggs, to remove stains and dirt, should only be done with specially designed washing machines and as soon as possible after collection. Poor washing of eggs will destroy the cuticle on the shell surface and although the eggs appear clean, bacterial contamination will be higher compared to normal clean nest eggs.

Wash water temperature should be 10°C warmer than egg temperature. This is to assist in reducing the possibility of microbial penetration into the eggs. The wash water temperature would therefore depend on the egg temperature. Specialized detergents are available from chemical supply companies for use in egg washing machines. After washing, the eggs should be rinsed with water which again is higher in temperature (2 to 3 °C) than the wash water. This water should contain an appropriate sanitizing agent such as sodium hypo chloride. Immediately after rinsing the eggs should be dried by fans blowing air over the eggs to avoid possible microbial penetration.

5.2.6 Sanitation of Hatching Eggs

Eggs should be sanitized as soon as possible after collection. There is always presence of bacteria on the shell surface and killing of such bacteria will reduce the risk of penetration through the shell.

Two basic practical methods exist whereby eggs could be sanitised:

Fumigation with the use of formaldehyde gas is the most popular method but is losing popularity due to the hazards involved in its application.

The use of sanitizing machines is gaining popularity but the machines are costly.

5.2.6.1 Fumigation of Hatching Eggs

Effective fumigation of hatching eggs is a proven means of reducing the number of bacteria on the shell. It is advantageous to fumigate eggs on the farm as soon as possible after collection. This reduces the time available for the bacteria to penetrate the shell of the egg.

Formaldehyde gas may be produced through heating of paraformaldehyde powder or by the chemical reaction between formalin and potassium.

When using the latter method the desired concentration of formaldehyde gas will be achieved with 45 ml of 40% formalin and 30 g of potassium permanganate per cubic meter of chamber. The eggs are to be exposed to this gas for 20 minutes at 20 to 25 °C. The formalin is added to the potassium and not vice versa. Gas masks and gloves must be worn during the process of handling these chemicals.

When using paraformaldehyde powder, 10 g per cubic meter of chamber will produce the desired concentration of formaldehyde gas. The powder is placed on an electric pan and heated for 20 minutes. Care should be taken when using dry powder in a heating pan as too low moisture content of the air will reduce the efficacy of the process.

The addition of a few ml of water to the evaporator will assist in maintaining the correct level of humidity.

An electrically heated pan is however easier to control and use compared to the use of formalin and potassium. The chamber should be equipped with an extraction system which extracts the formaldehyde gas after the time of fumigation has elapsed as well as a fan to circulate the gas within the chamber.

Poor results of fumigation could be due to:

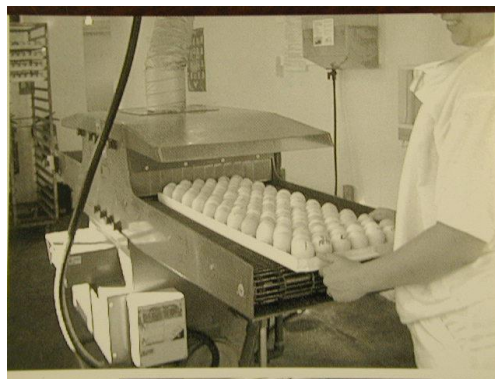
- Leaking fumigation chamber resulting in reduced exposure time

- Too much moisture absorbing the formaldehyde gas
- Inadequate circulation of gas and eggs stacked too close
- Insufficient chemicals
- Pulp trays absorbing gas
- Chamber walls should be smooth
- Excessive time between collection and fumigation

5.2.6.2 Egg Sanitising Machines

The use of formaldehyde is considered hazardous in many countries and there is a tendency to move away from this practice and to use sanitizers instead. This is achieved by passing hatching eggs through a sanitizing machine, which sprays a fine mist of the chemical over the eggs. These machines are generally more expensive than fumigation cabinets but are proving to be a good practice for egg sanitation.

The process of sanitation should be performed soon after collection before the bacteria has a chance of penetrating the porous shell.



Example of eggs on a setter tray being sanitised

When using sanitizing machines, the water should be 10°C warmer than the eggs and the sanitizing agent should be mixed at the correct concentration advised by the supplier of the chemical. The run off spray should not be re-used but allowed to run off into a drain system.

Poor results with sanitizing machines could be due to:

- Blocked spray nozzles
- Incorrect mixing ratio of the sanitizing agent
- Excessive time between collection and sanitizing
- Low water temperature

5.2.7 Grading and Hatching Egg Quality

It is desirable that only clean and good quality eggs be sent to the hatchery as hatching eggs and a process of grading such eggs should occur on the farm.

The extent to which second grade eggs are removed will be determined by the pressure being placed on hatching egg quality. With broiler breeders where less importance is

placed on shell quality, the percentage of hatching eggs of all eggs produced will be in the order of 92 to 95 %, inclusive of floor eggs.

For hatching egg production for egg laying strains, more emphasis is placed on shell quality and a figure around 90 to 91% is considered as being normal.

5.2.7.1 Egg Size

The egg size of breeder hens depends mainly on the breed and age of the flock as well as nutrition, environmental temperatures and age of maturity.

Chick size is related to egg size. As a rule of thumb the chick mass should be 65% of the egg mass. A 52g egg will therefore produce a 33.8 g chick under normal hatching conditions. Chick size is especially important in broiler production as 12.5 grams will be added to end live mass per 2.5g chick mass. In layer strains chick size may be of less importance, especially in integrated operations where higher chick mortality as a result of smaller chick size is justified by improved utilization of hatchable eggs. A lower limit of 50 g egg size producing a 32.5g chick is normally accepted for layer strains, especially in integrated operations.

The age of the flock at which saving of hatching eggs may commence would depend on the breed of bird. Generally it is safe to say that this can commence at about 50 to 60 percent production provided careful selection for egg size is applied. This should be achieved by 23 to 24 weeks of age in layer strains, and 26 to 27 weeks of age in most broiler breeds.

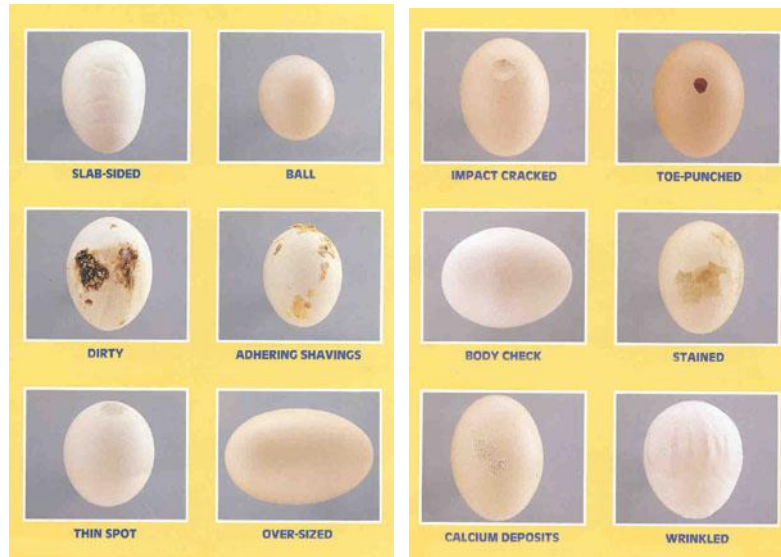
Extremely large (double yolk) and small eggs (< 50 to 52 g depending whether it is layer or broiler eggs) should not be set. Younger flocks produce smaller eggs but also more double yolk eggs at onset of lay.

5.2.7.2 Shell Imperfections

Many eggs have shell imperfections, some of which are inherited. Eggs with poor shell quality will invariably not hatch well or not hatch at all and should therefore not be set as hatching eggs especially in layer breeders. Shell imperfections would include: -

- Misshapen eggs
- Round eggs
- White eggs (no pigmentation)
- Rough shells
- Banded eggs
- Thin shells
- Very long eggs

Shell quality is genetically inherited but factors such as high ambient temperature, low levels of calcium and vitamin D are conducive to poor shell quality. The older the flock, the poorer the shell quality and diseases such as IB and NCD will also influence shell quality.



5.3 Hatching Egg Storage

Due to scheduling of hatches, especially in commercial layer hatcheries where chicks are produced for non-integrated customers, eggs may be held over for two weeks (and longer) to fit setting requirements. The conditions under which eggs are held will affect hatching results to a large extent. The egg holding room is to be kept clean and aired from time to time

5.3.1 Hatching Egg Storage Conditions

Hatching eggs held under optimum conditions for less than 5 days show very little deterioration in hatchability. As a rule of thumb, hatching time will be delayed by 30 minutes and hatchability reduced by 4% for every day that eggs are stored for longer than 5 days. The rate of deterioration is less between 5 and 10 days but accelerates after 10 days.

Since chick mass and quality play an important role in broiler weight, eggs from younger breeder flocks can be stored longer (compared to older flocks) because eggs from such flocks deteriorate slower in quality. This is due to better shell quality and hence less moisture loss, as well as better overall internal quality of eggs produced by a young flock.



Hatching egg storage should allow for air flow between trolleys

Plastic liners in egg cartons or plastic bags placed over egg trolleys are often used to reduce loss of moisture from hatching eggs to be stored for longer periods. Some hatcheries will store eggs in the small end up position, if eggs are to be kept for longer periods. Moisture loss is slowed down but eggs should not be transported in this position. This is often practiced in pedigree hatcheries where eggs are stored for periods longer than 10 days.

For sanitary reasons it is preferable not to store floor and non-hatchable eggs in the same cool room as hatching eggs.

Key points in storage of hatching eggs will include:

- Do not stack eggs trolleys too densely and especially not up against walls. There should be air movement through the egg stack especially during the cooling down process
- Air should move slowly over the eggs
- Ensure a smooth process of egg handling and do not allow eggs to remain outside of the cool room for too long
- Keep trolleys away from the walls so as to allow free movement of air
- Temperature and humidity control of the cool room is essential. Keep equipment in a well maintained condition

Some ventilation should be applied to storage rooms and the recommended level of ventilation is 0.1 m³ per hour per 1000 eggs.

5.3.2 Hatching Egg Storage Temperature

Although normal incubation temperature is in the order of 37 to 37.5 °C, the embryo will show development at temperatures above 24 °C, generally referred to as the embryonic threshold temperature. At lower temperatures embryonic development will cease.

The embryo will tolerate temperature fluctuations above and below this point before it is killed, but every time the temperature goes beyond this point, the embryo is weakened and its chance of survival and hatching is reduced. Cool room doors should be kept closed as much as possible and only opened when eggs are moved in or out of the cool room.

Eggs are stored below this threshold and the desired temperature would depend on the period before eggs are to be set. If for a short period (less than 5 days prior to setting) then temperatures in the order of 18 to 20 °C are common. When eggs are to be stored for longer periods (5 to 10 days prior to setting) then colder temperatures may be used (15 to 16 °C). If for longer periods then temperatures down to 12°C could be of benefit.

5.3.3 Hatching Egg Storage Humidity

Moisture that is held within the shell is continuously being lost to the environment through the shell. The relative humidity in the air will reduce the rate of loss; when humidity is low the rate of loss is increased due to a higher rate of vaporization.

The relative humidity of 75% is commonly used in egg holding rooms and this is measured by reading the wet-bulb and dry-bulb temperatures and determining the Relative Humidity from tables or from a psychrometric chart.

Humidity higher than 75% will not harm eggs but will result in any fibrous egg-cartons becoming soft. High relative humidity also enhances mould growth.

5.3.4 Moisture Condensation on the Shell

When eggs are removed from the cold room to an environment with a higher temperature, moisture will often condense on the shell surface. Such moisture could pick up bacteria in the air more readily and is therefore to be avoided.



Moisture condensation should be avoided

Two possible remedies may be considered. If possible reduce the relative humidity in the room to which the eggs are being moved. This is difficult and often not possible to achieve such as when moving the eggs to a vehicle transporting the eggs to the hatchery. A marginal increase in the temperature of the egg holding room may also assist in reducing condensation.

Eggs that are moisture-laden should not be fumigated with formaldehyde gas as the gas will penetrate the egg causing embryonic death.

5.4 Transportation of Hatching Eggs

When hatching eggs are to be transported over relatively short distances it is common to do so on trolleys with the eggs on egg or setter trays. Hatching eggs should be handled gently and allowed to settle (six hours) at the hatchery prior to being placed in the machines.

When eggs are to be transported over longer distances, especially when temperature and humidity cannot be controlled, then it is preferable to transport such eggs in carton boxes. Eggs are supported much better on pulp trays (reduced breakage) and once cooled, the eggs will be protected much better in pulp cartons.

Hatching eggs should also preferably be transported at temperatures which prevailed during storage.

6 Health and Hygiene

The manifestation of a disease depends on the aggravating (assist in bringing about the disease) and mitigating (assist the bird to combat the disease) factors. The disease causing agent such as viruses, bacteria protozoa and toxins must be present for a disease to manifest itself.

Various factors such as stress, low feed intake and poor environmental conditions are examples of aggravating factors caused by poor management. A well nourished bird, with a high level of immunity (well vaccinated) are examples of mitigating factors brought about by good flock management.

Poor control on the biosecurity measures on breeder farms will increase the risk of disease challenges which may occur. The breeder farm forms an intricate part of chick production and certain diseases may be spread vertically to the progeny, thereby placing chick customers at risk.



Flock health starts with controlling visitors to breeder farms

6.1 *Healthy versus sick birds*

In managing a breeder flock during rearing as well as rearing, it is essential to know and understand the difference in appearance between healthy and sick birds. .

Insert table

6.2 *Biosecurity*

Breeder sites must be managed on the basis of an all-in, all-out replacement cycle. Sites should be well separated from one another. With larger complexes and production operations, rearing farms should be separated from breeder farms. Most strict security measures should be in place on breeder farms to ensure that the birds will remain disease free and have the ability to express their full genetic potential.

6.2.1 Vertical and Horizontal transmission of diseases

Diseases may be transmitted to a site either by vertical or horizontal means.

Certain avian pathogens (micro-organisms) are transmitted vertically from the parent flock via the hatchery to the day old chick progeny.

Some diseases may enter the chain by horizontal transmission at any stage and then be transmitted vertically

To prevent vertical transmission of diseases it is advisable that day old parent chicks are sourced from a reputable supplier of which the disease status known.

It is also not advisable to mix chicks from different sources as the status of one source may impact negatively on the performance of others.

Pathogens may also be transmitted horizontally between farms, sites and poultry sheds. Important factors to be considered in horizontal transmission of disease include:

- An all-in, all-out replacement cycle should be followed on breeder farms
- Good separation between farms, sites and sheds is essential
- Control of access of staff and visitors to the site through showering and wearing of clean clothes and foot wear is advisable
- Access of service vehicles such as feed trucks should be controlled
- Feed should be purchased from feed companies who practice Salmonella control monitoring
- Vermin must be controlled

6.2.2 Flock separation

Poultry sheds and sites should be operated on the basis of single age groups per shed or site allowing for an all-in, all-out replacement cycle by shed or site. This is not only to enable depopulation and cleaning of the building to break any possible disease but in this period proper maintenance can be carried out and the building prepared for the next batch of birds.



Breeder farms should form separate interties

Breeder farms should be well separated from other poultry farms. The distance of such separation should be such that direct contact is not made and prevailing winds would also be taken into consideration.

The premises should furthermore be fenced off to assist in defining demarcated areas into which movement is restricted.

The buildings should be bird proof and no other birds or water fowl should be kept on the premises.

6.2.3 Control of movement

Movement of staff and visitors must be controlled and showering and wearing of clothes specific to the particular site is essential.

Of particular importance is the control of traffic such as feed trucks which may have contact with other poultry operations. Such vehicles should be clean and the vehicle disinfected when entering the premises. Buyers of end of lay hens have direct contact with other poultry and should not be allowed entrance to breeder farms. When disposing of end of lay breeders, the birds should be removed from the farm by vehicles and crates which are known to be clean and the birds transferred to the vehicle of the trader in a neutral point.

6.2.4 Sanitation

It is essential to ensure that the environment and premises does not carry over any pathogenic micro-organisms which could affect the health, welfare and performance of the subsequent flock. Day old parent stock may carry some parental immunity but this soon wanes and proper immunity should be built into the bird. Although point of lay breeder birds have been immunized against most of the common diseases, such immunity will not be adequate to face and withstand severe disease challenges.

6.2.4.1 Insect control

Insects such as litter beetles not only carry pathogenic micro-organisms but could also destroy building materials such as woodwork and roof insulation materials. Immediately after birds have been removed and while the building is still warm, the walls, litter and equipment should be sprayed with an insecticide. The insects will start to migrate to the warmer ceiling as soon as the building starts to cool down after removal of the birds and surfaces over which the insects migrate should be covered before this occurs.

Should the infestation be high a second treatment may be required. Warming the building will occur once the building is re-stocked and this will again attract insects into the building from the areas to where they migrated after removal of the birds.

The efficiency of the product being used should be monitored and changes made following consultation with specialists in this field.

6.2.4.2 Litter removal

Prior to removal of litter, all ventilation and electrical systems should be switched off and the building and equipment dusted down to ensure that such dust lands up on the floor. In open sided houses the curtains should be closed. This will assist in reducing the dispersing of possible micro-organisms through dust into the surrounding area.

The aim should be to carry out a proper dry cleaning of the equipment and building prior to removal of the litter.

The litter is then removed either manually or by mechanical means and as far as possible, spillage of litter onto surrounding areas must be avoided.

Litter should not remain or be stored on site.

6.2.4.3 Washing process

The washing process should consist of washing down the building, equipment and surrounding areas, using a high pressure water pump with a detergent added to the water. Prior to this process, all electrical equipment that could be damaged by water should be covered. The detergent is added to assist in removing dirt and greasy substances.

The process consists of washing down the building, top to bottom and eventually removing all water into drains outside the building. The surrounding areas including control rooms and ablution facilities are then cleaned, paying special attention to any residue material lying around. Once this process is complete, there should be no dirt, dust debris, litter or feathers visible in the building as well as surrounding areas.

Prior to placement of the next flock, the building is disinfected.

6.2.4.4 Cleaning water and feeder systems

In the case of the drinker system:

- All pipes and tanks should be drained and any possible sediment removed
- All pipes, tanks, lids, covers, taps, etc., should be washed with a detergent
- The drinker system should then be flushed out to remove any build up of sediments. This is of special importance with nipple drinker system and should be done in accordance with manufacturer recommendation. For alkaline water, vinegar or citric acid solution will remove mineral build up and for acid base water, household ammonia may be used.
- The system should then be flushed out with clean water and made ready for the next crop.

In the case of the feed system:

- All feed should be removed from the feed tank and feed system and disposed of
- The feed auger system should be removed from the feed tank
- Of special importance is to note any caking of feed onto the sides of the bin. Should this have occurred, the caked and mouldy feed should be removed and possible water leaking into the bin from outside repaired.
- The bulk feed bin should be clean out with detergent
- The system is then re-assembled and disinfected

6.2.4.5 Disinfecting

Once all equipment has been cleaned and repaired and attended to for receiving of the next flock, the building and equipment should be finally disinfected. This is done by

fumigation or by spraying the disinfectant. It is best to seek professional advice on appropriate products to be applied.

Fumigation with formaldehyde gas is an effective method of disinfecting poultry building. This is done by generating a 3 x dose of formaldehyde by mixing 20 ml formalin to 10 g of potassium permanganate per m³ of building for at least 30 minutes. The building should be closed, warm and only properly trained staff using gas masks and gloves should be allowed to use these dangerous chemicals.

Many producers are reluctant to use formaldehyde gas as a disinfectant due to the dangers involved in its use and other chemical disinfectants such as phenol and quaternary ammonia products, that are applied either by spray or fogging are used instead. It is best to seek professional advice in this regard.

Veterinary laboratories will also provide service for monitoring the efficacy of the disinfecting process.

6.3 Immunisation

The objective of vaccination is to ensure that there is controlled exposure to the disease organism (antigen carried in the vaccine) which will ensure a good response to the immunological response of the bird. This will actively protect the bird from subsequent natural field challenges. Although common diseases such as Newcastle and Infectious Bronchitis are routinely vaccinated against, vaccination places additional stress on the birds and the vaccination requirement and programs will vary according to circumstances. They should be devised and developed through veterinary assistance taking into consideration disease challenges in the area.

Two basic types of vaccines are used . Live Vaccines and Killed Vaccines each have specific use in immunizing breeder birds.

6.3.1 Live vaccines

Live vaccines are most commonly used to "prime" the immune system and to ensure a sustained high level of immunity. In floor breeder systems they are normally administered via the drinking water or by spray vaccination.



These vaccines carry the living organism (virus) that creates the disease. Because the virus has been attenuated (modified) the vaccine will cause multiplication of the virus within the bird without creating the disease itself. Vaccine reaction may however be noticed and the severity and consequences of the reaction will depend on the level of management (environmental control). Poor environmental control could cause vaccine

reactions to develop into severe secondary reaction of the respiratory tract, especially if such vaccines are administered via spray method.

The most common live vaccines used in commercial egg production include Infection Bronchitis (IB) and Newcastle (NCD). Normally the live vaccines contain only one antigen but combinations of IB and NCD are available.

6.3.1.1 Administering vaccines via drinking water

Most live vaccines need to be administered (consumed) within a period of between one to one and half hours after mixing. If shorter, vaccine may not be well distributed between all birds and if too long, vaccine will be destroyed. Vaccines such as gumboro need a bit longer (2 to 3 hours) to administer as the vaccine is more stable and good cover is necessary.



Administration of vaccine via the drinker system

The water intake of the flock at the time of administration should therefore be known. The hourly rate of consumption is then calculated and the amount of water to which the vaccine is to be added and consumed in the stated period is then calculated. Note that when water is withheld for an hour or two, intake will increase and this must be compensated for.

The vaccine should be added to water containing no trace of chlorine as this will inactivate the live virus. If such water is not available then skimmed milk powder may be added to the water (1 g per liter of water) and the recommendations of the vaccine supplier followed. By process of trial and error and building information data, the best procedure for particular circumstances and bird age will be found.

Even distribution is necessary and this is achieved by manually distributing the water into the open dry drinkers after water has been withheld in the case of Bell drinkers. Header tanks may also be used and it is essential to ensure that the drinker system is clean, free of chlorine residue and that water reaches all drinkers in the building within the given period of time.



Vaccine dosing

Live vaccines are best administered by using a dosing applicator. They are of particular interest in closed nipple systems. Dye tablets are available that assist in checking the distribution of water containing the vaccine. The dye will also mark the tongues of the birds and this may then also be used to check the percentage of birds that have in fact consumed the water to which the vaccine has been added.

6.3.1.2 Spray vaccination

Vaccines may be administered by spray method using various types of spray applicators available in the market. Some key point with spray vaccination include:

- Use applicator for vaccine application only and thoroughly clean the applicator after use. Avoid using soaps, detergents or disinfectants as residues may destroy vaccines. Rinse the equipment thoroughly with water.



Spray Vaccination

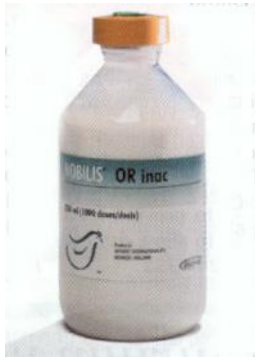
- In floor operations, herd birds into a smaller area (half the normal space) to ensure higher density and better cover. Portioning with low wire mesh frames will assist to keep birds controlled

- Reduce ventilation to the minimum. In open houses, close curtains.
- Reduce lights and in open houses it will be beneficial to spray vaccinate at night or late evening when birds may be kept calm through reduced light intensity

- Move slowly through the flock spraying with a "fanning" motion at birds not more than 3 meters away.
- Keep the vaccine at the required temperature (2 to 6 °C) until reconstituting and only mix sufficient vaccine that could be administered within one hour.
- The amount of water would depend on the applicator being used and this must be established through trial and error using guides supplied by the manufacturer. The vaccine must be administered within the period of one hour.

6.3.2 Killed vaccines

Killed vaccines are administered via injection .



Killed vaccines are composed of the inactivated organism (killed virus called the antigen) which is carried in an oil emulsion or aluminium hydroxide solution. This helps to increase the uptake of the antigen by the bloodstream over a period of time and these vaccines are administered by injection.

They are commonly used in breeder operations to ensure a high level of immune status prior to point of lay. The reaction time is slower compared to live vaccines but the immune status will be maintained for a longer period, compared to immunity induced by live vaccines.

Killed vaccines are administered via subcutaneous or intramuscular injection using a syringe such as a Socorex obtainable from most suppliers of vaccines. For needle sizes and length it is best to seek professional advice from veterinarians and vaccine suppliers.

6.3.2.1 Subcutaneous Injection

For subcutaneous injection, the skin on the back of the neck is lifted to create a pocket between the skin and neck muscles and the needle is then inserted through the skin into this pocket, with the needle pointing towards the bird's body. The site of injection should be the middle to lower neck region and not close to the head. Avoid injection into the neck muscles or close to the head. Do not inject on the side of the neck as blood vessels, nerves and even the trachea could be damaged.

6.3.2.2 Intramuscular injection

Intramuscular injection is normally done into the breast muscle by holding the bird on its back with the head toward the person administering the vaccine. The needle is inserted

midway between the tip of the keelbone and the shoulder joint as this is the thickest part of the breast muscle. The needle should be directed towards the abdomen, almost parallel with the breast bone. Avoid perpendicular penetration of the skin and muscle as the needle might then penetrate into the abdomen.

6.4 *Vermin Control*

The control of rats and mice in poultry sheds is very important, because they not only cause severe damage to electrical wires, plastic piping, cool pads and insulation material but are also carriers of numerous diseases.

Rats have huge appetites and consume poultry feed at a rate of 6 kg feed per day for every 100 rats. They are intelligent animals and are quick to become bait shy and even resistant to poisons and presentation, location and types of poison should be regularly rotated. Live stock is present in the poultry shed and care must be taken not to contaminate feed or water with poison.

6.4.1 Essentials in Rodent Control

Essentials of rodent control include: -

- When the shed has been depopulated and feed removed, rodent control should be stepped up
- Old and dirty poisons will not be consumed. Rather place smaller volumes in a number of bait stations on a more regular basis. Rats are territorial and aggressively protect their territory from intruders. Unless adequate bait distribution is provided, only those rats having access to bait in specific areas will die
- If poison intake does not occur at a specific site, then move the bait station to another location. Always try to identify the routes of the rodents. Rodent restaurants can even be tied onto cables or structural beams. Baits should be placed in the normal line of travel, and under cover so that they will feel secure when they feed. Rodents usually avoid open spaces. Grease marks are good indicators of rat traffic.
- Chicken sheds usually have an abundance of feed, making liquid poisons very effective if managed well. Liquid bait stations also have the indirect benefit of dissuading rats from chewing through the water drinker pipes in search of water. The addition of sweet wine or cheap sherry creates another alternative to increase
- Poisoned grain wrapped in newspaper can be stuffed into any holes used by rodents.
- Cement or seal any unnecessary holes in the building.
- Well-managed mechanical rattraps are a good investment.
- Remove spilled feed, especially under the feed silos and feed hoppers and eliminate feed wastage
- Check for signs of rodents at night using a flashlight and especially for rodent tracks and faeces on the feed in the hoppers during the early morning. Most rat activity, including feeding, occurs at night. If rats are seen during the day then the rat population is very high

- Keep grass very short or remove it around the sheds. Be on the lookout for rat holes in areas adjacent to the poultry buildings
- Where a rat infestation persists in houses i.e. where baiting is not able to intercept rats use of a gel painted onto the pipes, cables, bricks or posts which rats use to move around in the house can be used. The gel is picked up by the rat on its feet and fur and this is ingested when the rat grooms itself. A gel can be prepared by mixing 10 ml of liquid concentrate poison with 1 kg of a carrier such as Vaseline white petroleum jelly.
- Tracking powder poisons can be used in a similar way as gels.
- Sugar, vegetable oils and non-rancid animal fats increase the acceptance of cereal baits
- Keep water tanks completely closed.
- Limit the handling of bait with your bare hands. Rodents have very good smell and may reject the bait. It is advisable to handle the bait with a plastic bag.
- Do not scatter bait where it will be accessible to domestic animals or other non target species.
- Dead rats and mice found should immediately be placed in a mortality pit. Ensure that mortality pits are always sealed.
- Shed curtains (if they fold up) should be lowered and lifted completely at least once per week to discourage the formation of fixed paths and nesting sites for the rodents.
- Concerted efforts are needed during the winter. During this period more rodents move to the sheds from the veld in search of food and shelter.



Example of poor bait station and signs of rat movement

6.4.2 Edible Poisons

Edible poisons are divided into two main groups:

Multiple-dose anticoagulant baits must be consumed for several days to be lethal and are therefore safe for non-target animals. The effects are cumulative, therefore, it is imperative that enough bait be available for the rodents to eat for several days.

Single-dose anticoagulant baits only require a single meal with sufficient dosage to kill a rodent. These products can be lethal for non-target animals such as owls that consume the rodent.

6.5 Litter Beetles

Litter beetles are carriers of many diseases such as Mareks and Gumboro. Products used to combat litter beetles should be rotated regularly, preferably on a six monthly basis, so as to reduce the risk of resistance developing. Products may not be used in combination with any other cleaning, disinfecting or insecticidal agent unless prescribed. Litter beetles are specially targeted when the building has been depopulated and the building is cold. Beetles will then migrate to areas such as the ceiling where they can cause extensive damage to insulating material.

All cracks, crevices and hiding places where the beetle may seek shelter must receive special attention. Every treatment should include a band spray, 0.5 to 1 m wide and at least 0.5 m above the ground. All supporting posts must be treated with the band spray, including roof-supporting struts. Cracks in the wall and floor should also be sprayed. This is achieved with a knapsack spray. The knapsack sprayer should be fitted with a hollow cone nozzle, producing a spray angle of at least 30 degrees.

Thermal fogging may be used to disperse insecticide in an empty shed if the number of litter beetle builds up to unacceptable numbers.

6.6 Ectoparasites

Essentials in Mite and Lice Control should be followed in managing layer farms to combat problems associated with ectoparasites.

Normal biosecurity measures are as important with mite infections as with any other contagious disease.

- On breeder sites ensure that replacement stock is free of external parasites.
- Birds should be inspected regularly for mite and note that for Red Mite, such checks should be done at night or looking into crevices and cracks close to the birds
- Mites are occasionally seen on eggs and this is an indication of severe infestation.
- All treatments must consist of two poison applications, 10 to 14 days apart. This will ensure that the mite and lice eggs that hatch after the first application will also be killed, thereby leading to a much longer treatment interval.
- Treatment of the whole site will increase the treatment interval.
- Rotate Arthropod control products at least on a six monthly basis so as to reduce the development of resistance. Rotate between the main groups of products i.e. organophosphates, carbonates and pyrethroids.
- Additional poison treatments should only be given after discussion with the veterinarian.
- Spray after egg collection and for Northern Fowl Mite, ensure that vent area is properly wet.

6.6.1 Northern Fowl Mite

The life cycle of the Northern Fowl Mite is completed in less than one week on the birds. Eggs are laid on the feathers and hatch in one day. Unlike the Red Mite, the Northern Fowl Mite can be found on the birds throughout the day and night. The Northern Fowl Mite can survive for up to 3 to 4 weeks away from the host. It is an active bloodsucker and causes decreased egg production, feather pecking, loss of body mass, poor feed conversion and even death due to loss of blood during heavy infestation.

Other wild birds, rats and even humans carry the mites.

On fowls the mites tend to cluster in the soft, fluffy feathers around the vent but infested patches may also occur on other parts of the host. Generally a grey or black discoloration of the feathers around the vent, matting of the feathers and scabbing is seen in infested fowls.

Birds should be inspected routinely (weekly) and any spraying should be followed up after 10 days.

6.6.2 Red Mite

Red Mites do not live permanently on the host but feed only at night and conceal themselves in the premises during the day. The especially in cracks and crevices. The adults are resistant to starvation and may survive up to 5 months without a blood meal.

The life cycle of Red Mite is 7 days, so follow up treatment is to be done after 10 days to kill off progeny.

Red mite will therefore not be found on the birds during the day. They are more active during summer and seldom seen during winter. Crevices and cracks should be inspected and if birds are inspected, this should be done at night. Placing cotton wool under a heavy object in strategic points will attract red mite, and if present such area will soon reveal the presence of Red Mite on the cotton wool. They appear red when filled with blood but translucent during the day when blood has not been consumed.

It is an active bloodsucker and causes decreased egg production, feather pecking, loss of body mass, poor feed conversion and even death due to loss of blood during heavy infestation.

6.6.3 Lice

Lice spend their entire life cycle on the host. Eggs are attached to the feathers, and require 4-7 days to hatch. Their normal life span is several months, but away from the birds they can remain alive for only 5 or 6 days.

Bird lice eat feather products and may consume blood by puncturing soft quills near the bases and gnawing through the covering layers of the skin itself. Lice will transfer from one bird species to another if these hosts are in close contact.

Although the effect of lice on production is mixed, heavy infestation could cause production drops.

6.7 Internal Parasites

Internal parasites in breeder birds are mainly confined to worms and coccidia. Worms live off their host and because of their enormous capacity to multiply and the resilience of their eggs, the effect of worm infections should not be underestimated. Gastrointestinal worms will interfere with the normal digestive processes leading to poor feed utilization, growth and production. In breeder birds, fertility and hatching results will be negatively affected.

6.7.1 Large Roundworm

Of the worms that invade the intestines of breeder birds, the large roundworm (*Ascaridia galli*) probably inflicts the most damage. The life cycle is direct in that after being expelled from the bird via the faeces, the very well protected eggs develop into larvae which mature within 10 to 14 days, at which stage they are re-ingested and attaches itself onto the small intestinal tract lining. After another 21 days the larva develops into an adult in the small intestine of the bird and floats in it's content producing eggs 7 days later. The total lifecycle of the Large Roundworm is therefore in the order of 34 to 42 days. Mature worms are 66 to 70 mm in length, have a grey color and are easily visible with the naked eye.

A small infestation of large roundworm will do little damage but with a heavy infestation, birds will be unthrifty, growth and production will be affected and in breeders, fertility and hatching performance will be affected.

6.7.2 Small Roundworm

The small roundworm (*Heterakis gallinarum*) is also known as the cecal worm. The life cycle is very similar to that of the large roundworm except for the fact that the worms end up in the ceca of the bird instead of in the small intestine. The life cycle is also shorter (20 to 30 days).

They are smaller than the large roundworm (15 to 20 mm) and is of less importance in poultry production. In turkeys it is associated with blackhead disease.

6.7.3 Hairworm

The hairworm (*Capillaria obsignata*) is a very small parasite inhabiting the upper two thirds of the small intestine of the bird. It's life cycle is very similar to that of the large roundworm but shorter (20 to 26 days). The worm imbeds itself in the mucosa, where it will spend its entire life. The wall of the intestine will show hemorrhages and will be thickened. The greater the infestation, the more pronounced these signs.

As with other internal parasites, light infestations may go unnoticed but with heavy infestation, growth, feed utilization, production, fertility and hatching results will be impaired.

6.7.4 Tapeworm

The tapeworm that is of importance in chicken production is segmented flat worm (*Railletina cesticollus*), which may be very short to several centimetres in length. The head imbeds itself in the intestinal wall and new segments continue to grow behind it,

each being a separate entity. Segments at the end of the worm contain eggs and these break off and are passed from the bird through the faeces.

The life cycle of the tape worm is not direct and a host is required for the cycle to be completed. Intermediate hosts are generally insects and when the insects containing the ova of the worm are consumed by chicken, the life cycle is complete. In modern closed house breeding operations the tapeworm has become of little importance.

6.7.5 Worm Control

Effective control of worms firstly requires a good understanding of the life cycle of the worm in question. The three nematode species have similar life cycles in that they are direct but the time for the life cycles to complete differ. Large roundworm has a much longer cycle (35 to 40 days) compared to the small roundworm (24 to 30 days) and hairworm (20 to 26 days). The time that the larva takes to grow and mature inside the egg when outside the host, will depend on temperature and humidity conditions. Below 15°C eggs will generally not embryonate. Before embryonation, eggs are fragile and easily destroyed in environments hostile to them but after embryonation, they are very resistant and can survive for several years.

Although the life cycle of this worm is direct, worms can be ingested by earthworms, beetles, and other insects without being destroyed, and these vector hosts become potential reservoirs of infectious worm eggs.

Traditional worming by treating a flock every 3 to 6 months or even every month is not effective control. It may temporarily reduce the problem but due to the different life cycles of the worm in question, resistance of mature larvae and vector hosts, flocks may continue to be re-infected.

As a general rule the period between de-worming treatments should not exceed 5 weeks for the control of large roundworm and for control of small roundworm and hairworm, this should be with a maximum of three week intervals.

In many instances breeder birds are treated for worm just prior to being moved from the rearing to the breeder farms. Products used in such instances should be effective against the mature as well as immature stages of the worms. Some products may also reduce intake of water or feed (depending on the medium of administration) and professional advice should preferably be sought when developing a de-worming program.

Faecal worm egg counts carried out in laboratories are used to detect possible worm infestation. However, immature worms do not lay eggs yet, half the worm population do not lay eggs (male form), adult worms are not permanently probing eggs, and not all birds harbor similar numbers of worm. Egg counts therefore need to be done at regular intervals. Other symptoms of possible worm infestation include noticeably variable flock performance, poor growth, pale heads, anaemia and rough feathers, reduced fertility and hatchability, loose and frothy droppings and increased mortality.

6.8 Common Diseases in Breeder Flocks

Not all diseases found in South Africa are discussed here. This text merely provides a brief description of the more common diseases of breeder birds in South Africa and further detailed reading in special veterinary manuals and books is required to obtain an in depth knowledge on this topic.

6.8.1 Coccidiosis

Symptoms

Depending on the species of coccidia involved, external symptoms may vary from mild to severe. Symptoms include blood in the droppings, ruffled feathers, paleness, loss of appetite, low growth rate poor feed utilization drops in egg production and diarrhea. This is as a result of destruction of the lining of the intestinal tract, which in turn prevents absorption of nutrients into the bloodstream.

Internal symptoms are confined to the intestinal tract, including the ceca. Inflammation, hemorrhaging, lesions mucus and exudates are indicative of coccidiosis and due to the species being specific in the area of the intestinal tract infected, this is often used as to assist in identification of the species involved.

Cause

The coccidia that inhabit the chicken are of the genus *Eimeria*. Coccidiosis is spread by unicellular bodies known as *oocysts*. They are shed into the feces and must first sporulate at required temperature and humidity conditions before being ingested by the birds. Once ingested the sporulated oocyst finds its way back into the intestinal tract.

Transmission

The only method of transmission is through the sporulated oocysts being ingested and when birds are kept on litter, this occurs constantly as birds have contact with dropping. From house to house and farm to farm transmission is by mechanical means such as shoes, crates, pets, rodents, etc. Coccidia being parasitic live in the epithelial tissue of the intestinal tract where they inflict damage.

Treatment and Control

Coccidiosis is more easily prevented than treated. In breeder birds most control programs allow for natural development of immunity. As the birds are continuously consuming sporulated oocysts, there is a constant stimulation of the immune system. In these programs, coccidiocidal drugs, which at normal levels suppress oocyst production entirely, are used at lower levels to allow for oocysts to sporulate, be consumed and multiply at a low rate to allow for the immune system to develop immunity.

The drug can then be completely withdrawn and correct temperature and humidity in the litter ensures continuous oocyst sporulation and maintenance of the immunity level.

A second method of developing immunity in breeder birds is to inoculate for coccidiosis. Live oocysts are given to chicks through the drinking water or fed to chicks in a gel. Eventually oocysts are deposited in the litter, they sporulate the initial small numbers are ingested and the build up of immunity is initiated.

These programs may be considered expensive but there is better control compared to allowing immunity to develop on its own. Immunity starts at an early age and is fully developed at 5 to 6 weeks of age.

Causes of poor immunity and break in coccidiosis in breeder flocks could be due to:

- Litter too dry or too wet (seasonal changes) to allow sporulation
- Coccidiostat fed at too high level and no buildup of immunity
- Coccidiostat removed too fast
- Poor procedures followed during inoculation
- Drug resistance causing excessive build up of coccidia before immunity development

6.8.2 E. Coli Infection

Symptoms

Escherichia Coli are bacteria that represent one of the many coliform group of organisms that inhabit the lower part of the intestinal tract. Many of these organisms are harmless and most in fact assist with digestion. Some are however pathogenic and produce certain poultry diseases, including:

Airsacculitis, which is infection of the thoracic and abdominal air sack

Salpingitis, which is an infection of the oviduct

Synovitis, which is an infection of the leg joints and usually associated with other infections such as *mycoplasma*

and general *coli septicemia* in adult birds showing swollen livers, spleen and other internal organs.

Causes

Most *E.coli* infections start with a dirty and contaminated environment and poor environmental control. Good housekeeping, cleaning and disinfection of poultry buildings and good environmental control will reduce the risk of this infection.

Treatment and Control

The treatment of *E Coli* infection should start with its prevention through good housekeeping, creating a clean and healthy environment and good ventilation control.

Broad-spectrum antibiotics may be helpful following laboratory confirmation of the infection. Many *E. coli* are however resistant to commonly used antibiotics and a sensitivity test should be conducted by the laboratory to identify the best drug for treatment.

6.8.3 Egg Drop Syndrome

Symptoms

The symptoms are most exclusively associated with a decline in production, and the loss is primarily associated with the fact that eggs do not have shells (shell-less). Production loss can be between 40 and 50% for varying length of time, up to 10 weeks.

Very little other symptoms are seen.

Cause

This disease is caused by an adenovirus which was identified for the first time in 1976, and is thought to be spread by migrating waterfowl.

Treatment and Control

There is no known treatment and the control rests with the use of inactivated vaccines administered to pullets prior to lay (14 to 16 weeks). Waterfowl should not be allowed on farms.

6.8.4 Fatty Liver Syndrome

Symptoms

This condition only appears in flocks with good production. Birds are in good health and sudden drops in production and increased mortality occur. Post mortem examination will reveal an enlarged liver, which is fatty, friable and tan in color. The birds will also be excessively fat. Mortality is mainly due to rupture of the liver with gross hemorrhaging.

Causes

Fatty liver is a metabolic disorder in hens which causes excess fat in the liver. The exact causes for this is not fully understood, but factors such as toxins, nutritional imbalances, very high energy diets and endocrine imbalances are thought to be involved. There may also be a genetic connotation. Although the condition is not induced experimentally, there is sufficient evidence that the syndrome is of nutritional origin.

Treatment and Control

A reduction in energy intake, adequate body weight control in broiler breeders and correcting possible nutritional imbalances remain the only possible control measure. In some instances the addition of vitamin E, B₁₂ and choline chloride has been beneficial but not in all cases.

6.8.5 Infectious Bronchitis

Symptoms

Infection and spread in adult birds is rapid. Very little external symptoms are noticed and the disease manifests itself in adult birds by a severe drop in production. The return in production will take several weeks and egg quality is severely affected. Eggs are soft shelled, misshapen, wrinkled and chalky. With brown-shelled breeders many eggs with lighter shell colour will appear. Production may return to normal but egg quality seldom does. It is best to have this disease confirmed by laboratory diagnosis, although this could be difficult in many instances.

Causes

This highly infectious disease is caused by a virus which has a propensity towards genetic mutation and many serotypes therefore exist. Although various vaccines are available, this disease continues to pose problems within the industry, especially during colder winter period.

Treatment and Control

There is no treatment. Good vaccination, routine serology tests to follow possible challenges and good biosecurity measures remain the best method of combating possible outbreaks.

6.8.6 Infectious Choryza

Symptoms

Facial swelling together with snicking and discharge from nasal and sinus passage are common. When complicated by *Mycoplasma gallisepticum*, nasal passages and sinuses become filled with a cheesy exudate. Production drops could be severe.

Cause

This disease is caused by the bacterium *Heamophilis paragallinarium*, and can cause severe production drops.

Treatment and Control

Antibiotics are used to treat this condition, but success could vary. Vaccines are available to vaccinate against the disease but good biosecurity measures and hygiene control remain the main preventative measures.

6.8.7 Marek's Disease

Symptoms

Lameness and paralysis is typical and the disease is often diagnosed by the presence of enlarged peripheral nerves that appear yellowish and have lost their typical cross striations. It often occurs in flocks close to or during onset of production and mortality loss could be high. Tumours of the visceral organs may or may not occur. In some cases it may be difficult to differentiate the tumours from those caused by lymphoid leucosis.

Cause

This disease is caused by a herpesvirus and several serotypes have been identified. Birds become infected in early life and remain infected until death.

Treatment and Control

There is no treatment. The only control remains good biosecurity, cleaning and rest period of farms and adequately vaccinating the day old chicks before placement. Breaks in MD are often traced back to poor vaccination, poor vaccine handling as well as poor immune response of the chicks. It is best to involve veterinary advice with MD breaks, as the causes and control need to be traced back to the chick hatchery and pullet rearing farm.

6.8.8 Mycoplasma Gallisepticum

Symptoms

In mature birds the disease may go unnoticed. Close observation may reveal depressed and inactive birds and a slight nasal discharge and snicking may be observed. A diarrhoea may be noticed and feed consumption drops with a consequent effect on production. The severity of the disease would depend on the level of stress, environmental conditions as well as the involvement of other diseases and challenges.

Of particular importance is the involvement of coliform bacteria and respiratory viruses which then typically results in airsacculitis.

Cause

This disease is caused by small organism which is delicate and which has no cell wall. The organism may remain dormant and cause no disease until the bird undergoes some stress at which point the disease becomes active. Birds remain carriers of the disease and transmit the disease to other birds. MG is an important disease to control in breeders as this a disease which will be transferred vertically from the parent flock to the progeny, causing severe difficulties in the progeny.

Control and Treatment

Tylosin is an antibiotic specific for the treatment of birds infected with MG. Other drugs such as aureomycin and erythromycin may also be used effectively.

Medication and treatment of MG can only be considered to be a temporary solution and proves to be expensive. If left untreated, production losses could be high. Eradication and maintaining a MG free breeder farm should remain foremost in the disease control program.

This is one disease that remains to be a problem on many farms due to poor biosecurity measures and allowing buyers of end of lay onto farms.

6.8.9 Mycoplasma Synoviae

Symptoms

In adult stock respiratory symptoms are often not seen. There may be a loss in appetite and weight. Inflamed leg joints (hocks) cause birds to become lame. A persistent tenosynovitis may be evident and morbidity rather than mortality is a problem. MS will often go unnoticed unless routine serology is performed.

Cause

This disease is caused by a small delicate organism that has no rigid cell wall. The disease is transmitted vertically via the breeder farm, through the egg to the progeny but may also be carried onto the farm through contact with other birds, either direct (wild birds) or indirect (contaminated staff, vehicles, visitors, etc.)

Treatment and Control

Broad spectrum antibiotics may be of some value but usually MS will not cause major losses in layer flocks, unless the hocks are particularly inflamed causing birds to become lame and unable to feed. MS negative stock should be sourced followed by strict biosecurity to maintain a disease free breeder farm.

6.8.10 Newcastle Disease

Symptoms

Symptoms will depend on the pathogenicity of the virus. This disease is commonly vaccinated for and problems on farms are often associated with poor vaccination or severe challenges. A mild respiratory condition may be observed coupled with a drop in production, the extent of which would depend on the challenge and level of immunity. Often nervous symptoms (twisted necks) are observed. Egg shell quality may also

deteriorate, but again this will depend on the challenge and level of immunity. Serological testing is required to confirm NCD.

Cause

Newcastle disease (NCD) is caused by a virus and although only one serotype, there are three forms classified, according to their pathogenicity: Velogenic (high pathogenic), Mesogenic (medium pathogenic) and Lentogenic (mild pathogenic). The virus spreads very easily and rapidly through the air, through contact (clothing, feed trucks, equipment, etc.), between flocks, wild birds, predators, etc.

Treatment and Control

There is no treatment for NCD. Broad spectrum antibiotics may be used to medicate for secondary diseases which often manifest during a NCD challenge.

Routine serology to monitor the immune status and adapting the vaccination program accordingly is of importance. This is best achieved through seeking professional veterinary advice.

6.8.11 Mycotoxicosis

Symptoms

Morbidity as well as mortality are usual in most of the toxins.

Aflatoxin will generally cause impaired immunity, increased bruising and blood clotting time, alter the protein and fat metabolism lower the resistance to other diseases and reduce pigmentation.

Ochratoxin will reduce feed consumption, cause urate deposits throughout the body cavity and impair kidney function.

Fusariotoxin causes sores and lesions in the mouth and feet, reduces egg production and shell thickness, causes reduced feed intake and body weight and poor feathering.

Cause

Mycotoxicosis is caused by toxins produced by various molds. The molds grow on grains and under conditions such as high temperature and moisture, the toxins are produced. The most common mycotoxins encountered are: Aflatoxin, Ochratoxin and Fusariotoxin.

Treatment and Control

The best treatment is to find and remove the source of mycotoxin. This includes feed bins

6.8.12 Salmonellosis

Symptoms

Most paratyphoid bacteria cause very little disease symptoms.

However, many of these bacteria may infect humans, especially the young and old or humans weakened through chronic or immune suppressive diseases. The bacteria is thought to penetrate the egg through the shell and *S. enteritidis* especially has been implicated in many cases of human infection. Other forms of contamination include fecal contamination, ovary transmission, contamination via staff as well as via the feed.

Causes

There are many *Salmonellae* that cause disease in poultry. While pullorum disease and fowl typhoid were of importance to the industry prior to their control and virtual elimination, the paratyphoid form of the disease, which is the non-chicken specific form of the disease has in recent years threatened the industry through public health concerns.

Treatment and Control

It serves very little purpose to treat a flock infected with paratyphoid, although some drugs may act indirectly by reducing the organisms in the intestinal tract and thereby decreasing the number of bacteria deposited on the egg shell. The reduction or exclusion of paratyphoid organisms is difficult as they occur in many species (including humans). Control of this bacteria is of importance and quality-assurance programs should be developed in discussion with professional veterinary advice to suite particular circumstances. These programs would include the following:

- The possible use of vaccines
- The use of competitive exclusion products which are aimed at populating the gastrointestinal tract with adequate number of normal beneficial bacteria in an effort to reduce the harmful paratyphoids
- Elimination of the use of feed ingredients which are of animal origin and purchasing feed from a reliable feed supplier
- Ensuring that water is not contaminated
- Good control on rodents
- Good cleanout and disinfection between flocks