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Broiler Management in Southern Africa

Compiled by Alan Saunders

Foreword

The broiler industry has undergone phenomenal changes since the 1950's when growing of chickens on commercialized farms became a reality. The industry, in continual pursuit of improved efficiency, has demanded rapid growth rate and breeding companies, the feed industry as well as equipment supply companies have all contributed significantly in the continued improvements in growth rate and feed efficiency.

Over the years the management of broiler stock has focussed primarily on maximizing the genetic growth potential that exists and improving feed efficiency. This has however not been achieved without some negative trade-offs and modern high yielding broilers need management care of very high standard in a very competitive industry. Adverse environmental/genetic interaction which could have disastrous consequences need close control and supervision. The consumer is rightfully so, requesting a more uniform product and is setting very high quality standards. This will have to be met if the industry is to continue growing at the rapid pace seen over the past 5 decades.

Detailed knowledge of broiler housing conditions, equipment, management techniques and the handling of some of the more common disease problems is essential for successful broiler production.

This book endeavours to supply details of housing conditions and equipment and general management techniques that are considered to be essential for successful growing of broilers. It forms part of a series of books on poultry management and housing which are available from the address.

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.

Contents

1 Broiler Housing and Equipment

Broiler growing should be aimed at providing the bird with a clean and hygienic environment in which temperature, condition of the air and light are as close as possible to what is required by the birds during the various stages of development.

A variety of housing systems and equipment are available to the broiler industry. This could range from the very basic to sophisticated systems in which the environment is completely controlled by mechanical means. Whatever system is used, the aim should be to achieve optimum performance in terms of growth, uniformity of the flock, feed efficiency, yield and quality, without compromising health and welfare.

Broilers grow at a very rapid rate and attention to the environment and equipment may require daily adjustment to meet the changes taking place to cope with the phenomenal increase in biomass within the confinement of the building.

1.1 Farm Layout and Planning

The size of the farm and individual houses will depend on whether the complex forms part of a larger integrated broiler operation or whether a smaller independent market is to be supplied.

A typical integrated broiler business would consist of breeder farms (which could also include control of Grand Parent Farms), day old chick hatcheries, contract or company owned broiler farms and broiler processing and marketing.

Smaller broiler businesses will purchase day old chicks from broiler chick hatcheries and supply grown broilers to smaller slaughter plants or even trade in live broilers.

1.1.1 Key Planning Points

Whatever the size, some key points need consideration when planning a broiler farm.

With large farms that may form part of an integrated operation, the farm size needs to be such that it is placed and processed on an all-in, all-out basis. This is to ensure that the farm is completely cleaned and disinfected prior to placement of the next batch. Individual farms should also to be well separated from other poultry farms to ensure sound biosecurity measures to be followed.

With smaller operations, the shed size must be such that the birds are processed within a short period of time to enable complete depopulation, cleaning and disinfecting of the building prior to placement of the next batch. Smaller broiler farms are normally multi-age and the buildings should be separated as much as possible from one another. .

The period from slaughter to placement should be at least ten days but preferably two weeks to provide sufficient time for removal of litter, cleaning, disinfecting and preparing for the next batch of chicks. If birds are being processed at an age of 35 days, the complete cycle will be 49 days with a 14 day period between cycles (35 days growout plus 14 days cleaning and preparation) and 7.4 placements per year will be possible. With a period of 10 days between cycles the cycle length will be 45 days and 8.1 placements will be possible per year. The key question would be whether the shorter

10 day period is sufficient to allow for adequate time to remove litter, clean and disinfect the premises and allow for preparation for the next placement.

Other key issues include:

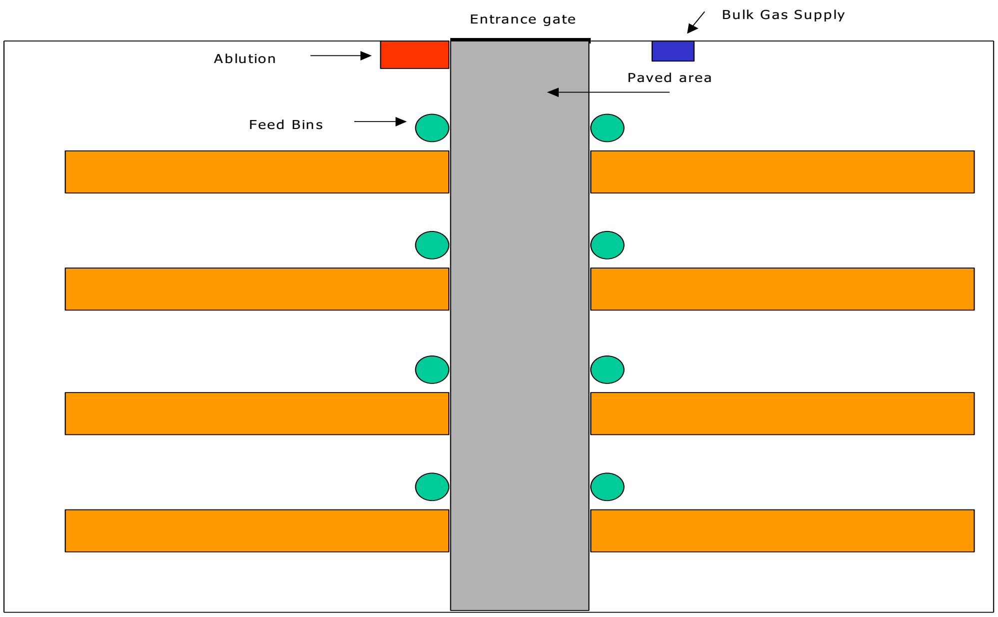
- The premises should be fenced off and the enclosed area kept clean and grass kept short
- The premises should be well drained to ensure that rain water runoff is adequate
- The premises and poultry buildings should be easily accessible to heavy vehicles (feed trucks, chick trucks and live bird transport vehicles)
- Access for all staff and visitors to the farm must be strictly controlled, preferably through showering but at least through change of clothing and footwear into the fenced off area
- Arrangements need to be made for adequate disposal of mortality
- 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

- Supply requirement of feed and disease free chicks from reputable suppliers as well as adequate quantities of potable water, including water storage need to be planned for.

1.1.2 Farm Layout

The layout of the farm should be such that poultry sheds are well separated from one another (1.5 to 2.0 times the width of buildings) and preferably with the length running east to west (to reduce heat load of sun on walls) taking into consideration prevailing wind direction, especially in the case of natural ventilated houses.

A typical broiler farm layout would be as illustrated below.



1.1.3 Supply Requirements

A reliable supply of quality disease free day old broiler chicks from a reputable hatchery is essential. A rate of mortality in the order of 5 to 6% should be allowed for when calculating the number to be available for slaughter.

Quality feed from a reputable feed supplier is essential. The feed consumed by the birds would depend on the breed as well as rate of growth rate that is being achieved. As a guide the approximate feed requirement may be calculated from data presented in Table 1.1.

Table 1.1: Feed consumption of broilers

Period (days)	Feed Intake (kg/1000)	Cumulative Feed (kg/1000)	Daily Average (kg/1000)	Body Weight (g/bird)
0 to 7	136	136	19	160
8 to 14	310	446	44	400
15 to 21	594	1040	84	830
22 to 28	960	2000	135	1350
29 to 35	1200	3200	171	1900
35 to 42	1300	4500	185	2400

Sufficient supply of clean cool potable water should be available. Approximate water consumption of broilers at 20 to 25 °C is presented in Table 1.2. These requirements will depend to a large extent on environmental temperature conditions but serve as a guide.

Water storage should be adequate and supply pipes buried deep to ensure cool water supply during hot weather conditions.

The water quality requirement is presented in Table 1.2.

Table 1.2: Approximate water consumption of broilers

Age (days)	Average Daily (ml litre/1000)	Water Required (litre/1000)
0 to7	42	300
8 to14	95	680
15 to 21	185	1300
22 to 28	300	2100
29 to 35	370	2600
36 to 42	400	2800

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, the excess must be removed from the building and is achieved by ventilation as well as the use of evaporative cooling systems.

On the other hand during conditions where environmental temperatures are lower than the temperature requirement of the birds, the heat produced by the birds should be preserved and used to assist in maintaining house temperatures within the certain limits. Where birds are young (chicks) and the heat generated by the stock is insufficient to maintain house temperature, artificial heating is used to ensure that temperature remains within the desired limits. Under these conditions, a minimum amount of ventilation should be applied to ensure sufficient removal of moisture and gasses such as ammonia and carbon dioxide and sufficient supply of oxygen.

Illumination of the building also forms part of environmental control and broilers require different lighting conditions during various stages of development.

1.2.1 Temperature Requirement

Broilers are very sensitive to temperature conditions and breeders provide guides for particular stock. Table 1.3 may be used as a guide for ideal broiler temperature but specific breeder guides as well as bird behaviour should provide details for improved management.

At environmental temperature conditions within these norms, broilers are able to maintain body temperature within normal ranges without having to apply mechanisms to increase body heat loss or body heat production when temperatures slightly are above or below the norm. This is commonly referred to as the thermo neutral temperature zone.

Table 1.3: Brooder and house temperatures for broilers

Age (days)	Whole house Brooding At bird level (°C)	Spot Brooding 2 m from brooder (°C)
Day old	32 to 34	34
2	30 to 32	32
3 to 7	28 to 30	30
8 to 14	25 to 28	28
15 to 21	23 to 25	23 to 25
22 to 28	21 to 25	21 to 25
29 to slaughter	20 to 25	20 to 25

Environmental temperature both below and above the ideal range will affect performance and production efficiencies of broilers.

Temperature below the ideal will result in increased metabolic activity which is aimed at maintaining body temperature. This results in an increased feed intake, which not only results in deterioration in feed efficiency but may also cause increased mortality due to ascites. The reason for this is that the requirement to metabolize increased amount of feed, coupled to the increased demand for oxygen to accommodate the increase in metabolic rate, sets up an ideal situation for ascites.

The metabolic rate in broilers is already very high due to the bird's growth rate. This creates a high demand for oxygen and increases the load on the heart to supply sufficient quantity of blood to the lungs. The low temperature will therefore put additional load on the heart which results in the typical ascites condition of enlargement and dilation of the right ventricle, failure of the heart and accumulation of fluid in the ventral hepatic, peritoneal or pericardial spaces.

Temperatures below the ideal should therefore be avoided at all stages of broiler production.

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. Should temperature increase even further, heat loss through evaporation of moisture from the epithelial tissue of the respiratory tract (panting) increases and under these conditions the supply of fresh cool water is important. To compensate for the increase in body temperature, feed intake will decline. The consequent reduction in nutrient intake will result in reduced growth rate and poorer performance.

Environmental temperatures that are outside of the thermo neutral zone of the birds at various stages of development should therefore be avoided.

1.2.2 Moisture in Broiler Houses

Control of the moisture content of the air within buildings is important in broiler production because it affects litter quality and overall conditions within the poultry shed. Broilers are reared on litter systems at high stocking density and the quality of the bedding may soon deteriorate. This leads to high levels of ammonia, breast blisters, problems with hocks and foot pads and generally poor production efficiencies. Conditions within the building should be maintained as close as possible to the ideal.

Moisture production in the broiler shed is influenced by various factors:

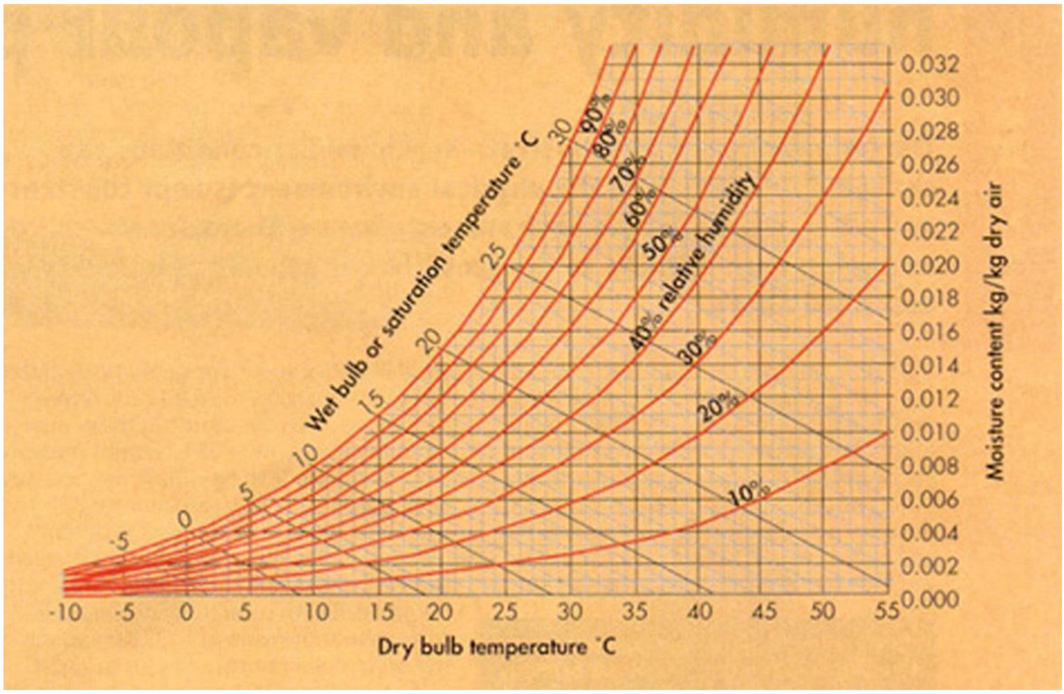
- Excessive levels of dietary salt causes increased water intake and increased kidney activity to remove the sodium from the body, resulting in wet litter conditions
- Increased energy content of the diet increases water consumption and results in faeces with higher moisture content
- Pelleted feed produces 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
- Any form of controlling feed intake results in birds tending to consume more water

Warm air can hold more moisture compared to cold air and warm air in the building can therefore remove more moisture from the building. Insulating poultry sheds to conserve the heat in the building 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 warm but also dry.

1.2.3 Psychrometrics of Air

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.

Upon viewing the Psychrometric Chart closely it will be seen that at 20°C (read on bottom axis) and 70% relative humidity (RH read on the curved red lines) the wet bulb temperature will be 16°C (read on uppermost curved red line) and the air contains approximately 10g of water per kg dry air (read on the right axis). If the air temperature is increased to 25°C at the same amount of moisture (10g/kg of air), the RH drops to close to 50%. In order to get back to 70% RH the water content of the air has to increase to 14g/kg dry air (40% more). This illustrates the fact that when temperature of air declines the RH increases and the opposite is also true   Cold conditions induce wet litter and warm conditions create dry litter.



Standard Psychrometric Chart

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

1.2.3.1 Dry Bulb Temperature

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 broilers 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.

1.2.3.2 Wet Bulb Temperature

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.

1.2.3.3 Relative Humidity

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.

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.

1.2.3.4 Specific Humidity

The specific humidity differs from the relative humidity 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.

1.2.4 Decomposition of Litter

Wet litter conditions in floor systems are conducive to foot problems, breast blisters and excessive levels of ammonia which will exacerbate any respiratory disease. Litter consists of biodegradable materials such as straw, wood shavings and also manure. Under normal conditions decomposition will occur and depending on the humidity and density of the litter, the decomposition could be anaerobic or aerobic.

1.2.4.1 Anaerobic Decomposition of Litter

Anaerobic decomposition of litter (oxygen deficient) 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.

1.2.4.2 Aerobic Decomposition of Litter

This form of litter decomposition supports the growth of bacteria. 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.

1.2.5 Gasses in Boiler Sheds

Several gases are found in poultry sheds some of which are required at minimum levels (oxygen) and others which will result in reduced performance or even death at high concentrations. 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 gasses or insufficient supply of oxygen.

Minimum and maximum tolerated gas composition of air is illustrated in Table 1.4.

Table 1.4: Tolerance for gasses in air

Gas	Outside Air	Inside Air
Oxygen	21vol. %	Min 15 vol.%
Nitrogen	78 vol. %	Max 84 vol. %
Carbon dioxide	0.03 vol. %	Max 0.25 vol. %
Carbon monoxide		Max 40 ppm
Ammonia		Max 20 ppm
Hydrogen sulphate		Max 10 ppm

1.2.5.1 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. Ammonia is especially bad for broilers as it causes the cilia of the respiratory tract (fine hair like microscopic protrusions) to stop their "sweeping" movement. This leads to respiratory problems. High concentration for longer periods also leads to blindness.

Levels of ammonia should be less that 10 parts per million 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 rates 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 litter conditions through the removal of sufficient amount of moisture from the building. Further control rests with the ability to keep the manure as dry as possible through elimination of water spillage. Over ventilation will on the other hand create dry dusty conditions.

1.2.5.2 Oxygen

Continued selection pressure on weight gain and body weight of modern broilers has resulted in high metabolic rate. This places increased demand on organs such as the heart and lungs to cope with the increased metabolic rate and although this is taken into consideration in broiler selection programs, the modern broiler is more susceptible to skeletal and cardiovascular disorders.

Broilers have a high demand for oxygen and this increases the load on the heart to supply sufficient quantity of blood to the lungs. Any suboptimum levels of oxygen will therefore put additional load on the heart and these results in the typical ascites condition of enlargement and dilation of the right ventricle, failure of the heart and accumulation of fluid in the ventral hepatic, peritoneal or pericardial spaces.

The supply of adequate levels of oxygen at all stages of broiler production through sufficient levels of minimum ventilation is essential. This should however not be at the expense of not maintaining environmental temperature within the thermo neutral zone, especially during winter as cold conditions could also induce ascites.

1.2.6 Illumination in Broiler Sheds

The general practice in broiler production is to provide continuous light (or at least 23 hours) to broilers. This is intended to maximize feed intake and daily gain. The 1 hour darkness is used to accustom birds to darkness in case of power failure. The light system must provide for an even distribution of light at adjustable intensities form 20 to 30 lux down to 5 lux for normal broiler rearing and down to 0.5 lux in houses where light programs are to be used to adjust the growth pattern.

Breeders would recommend various light programs based on the growth of the flock and particular circumstances. The basis of the programs is to slow down growth at critical periods and accelerate growth again towards the latter part of the growing period.

The light intensity in broiler sheds needs to be adjusted to suite varying requirement.

Light intensity is measured in foot-candles or lux. One foot-candle = 10.76 lux.

As a general rule, 1 bulb watt for every 0.37 m^2 of floor area will provide for 10 lux (1 ft candle) when incandescent lights are used under reasonably good reflectors. When using fluorescent light, 1 bulb watt for every 1.11 m^2 will supply the equivalent of 10 lux (three times more efficient).

Broiler chicks are provided with a light intensity of 20 to 30 lux for the first week to assist the chicks in finding the drinkers and feed. Thereafter the intensity is gradually reduced to around 5 to 10 lux in closed houses by two to three weeks of age. Birds should not be exposed to the very high light intensity caused by direct sunlight. Other than more difficulty to dispose of body heat under such conditions, this very high light intensity could lead to increased pecking and cannibalism resulting in increased mortality as well as poor carcass quality. Reduced activity also improves feed efficiency.

In dark houses where light programs are used to modify the growth pattern, the light intensity should be below 0.5 lux.

1.3 Natural Ventilated Buildings

Natural ventilated houses are houses where the amount of air entering the building through natural forces is controlled by opening and closing of side wall air inlets. These natural forces are through Stack Effect and Air Pressure Effect. The roof area of these buildings should be insulated and a white surface to reflect solar heat will assist in reducing outside heat load during summer. The side walls normally consist of a low wall (30 to 40 cm) and the open area is covered with bird proof mesh and an adjustable curtain.

Natural ventilated or Open Sided Poultry Houses

Advantages of Natural Ventilated Houses

They are easier to construct and less expensive to establish (cost per unit area)
They are simple to operate
No emergency power is required
Operating cost is low due to lower electricity used and lower maintenance cost

Disadvantages of Natural Ventilated Houses

It is more difficult to ensure correct environmental conditions within the building, especially for young growing birds
Stocking density is lower compared to fan ventilated buildings
High light intensity could result in pecking, scratching and poor carcass quality

1.3.1 Stack Effect

The stack effect of air movement in the building (also often referred to as the chimney effect) is as a result of warm air rising and colder air moving in through inlets. To make use of the stack effect air outlets or ventilators are placed in the roof and inlets as low as possible on the sidewalls.

The possible amount of ventilation through the use of the stack effect is relatively small and a large temperature difference is required before air will move as a result thereof. Its importance in ventilation of naturally ventilated poultry buildings is therefore limited and used only in creating minimum ventilation in these houses as this is the period when a fairly wide temperature difference exists.

1.3.2 Air Pressure Effect

When wind blows against the building, a positive air pressure is created on the wind side of the building and a negative air pressure on the opposite side. Should openings be placed on the sidewalls, air will move into the building on the positive pressure side and out of the building on the negative pressure side.

Greater wind speed increases the airflow through the building. The amount of airflow through the building may be controlled by opening and closing the side inlet and outlet areas in relation to the wind speed and amount of ventilation required.

Under conditions of no wind, very little ventilation will be achieved. Fans may then be mounted inside the building to assist in air movement and increasing sensible heat loss. These fans are not to be seen as ventilation fans but are used only to stir the air and through wind chill create an improved condition within the building.

1.4 Mechanically Ventilated Buildings

Mechanically ventilated houses are houses in which air is moved by making use of fans. The roof area should preferably be insulated and the light system must provide for an even distribution of light at adjustable intensities from 20 to 30 lux down to 5 lux for normal broiler rearing and down to 0.5 lux in houses where light programs are to be used to adjust the growth pattern. The ventilation system must provide for uniform air quality and required environmental conditions at all times.

Advantages of mechanical ventilated houses

Stocking density can be increased compared to open sided houses

It is possible to ensure optimum environmental conditions within the building, provided the building is properly designed and the system is operated accordingly

Heating cost in rearing stock is reduced due to better insulation of walls and control of the ventilation rates

Light intensity can be controlled and light programs used to modify the growth pattern of the birds

Disadvantages of mechanical ventilated

The houses are more costly per unit floor area compared to open sided houses

Fan ventilated houses require emergency power supply

Such houses have higher operating and maintenance cost due to electrical supply and more mechanical equipment

Modern mechanically ventilated broiler houses

1.4.1 Minimum Ventilation

A minimum amount of ventilation needs to be provided for, irrespective of temperature. This is to ensure adequate supply of oxygen to the building and also removal of metabolic gasses such as carbon dioxide and ammonia as well as moisture produced by the birds.

1.4.1.1 Minimum Ventilation Requirement

The minimum ventilation required may be calculated by using the following formula suggested by Agriculture Development and Advisory Service (ADAS) in the United Kingdom.

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

ALW = average live weight in kg

For broilers the minimum ventilation required per bird would depend on the age (body weight) of the birds as they grow from day old weight to the slaughter weight. Using the ADAS formula the minimum ventilation as it would apply to broilers is illustrated in Chart 1.1 below.

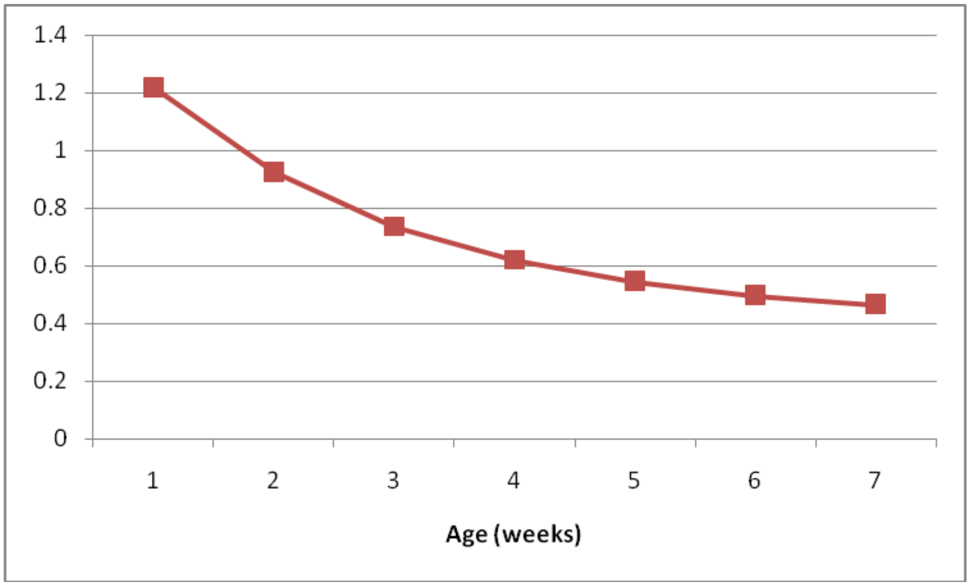


Chart 1.1: Example of the minimum ventilation required for broilers using the ADAS formula (cubic meter/kg live mass/hour)

The above is applicable under normal conditions of temperature and humidity. At high levels of humidity, especially when ambient temperatures are 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. Minimum ventilation under high humidity conditions therefore requires special attention.

The rate of ventilation required to remove sufficient quantities of moisture from the building (maximum of 75% RH inside the building) will be influence by the temperature and humidity level of the incoming air and this may be calculated by using the following formula:

V min. (m^3/hr/bird) = X/(Xi-Xo)

X = water vapour production of the birds (g/hr)

Xi = water vapour content of air inside the building at 75% RH

Xo = water vapour content of air outside the building

Xi and Xo may be obtained from Psychrometric Charts

Using this formula it can be calculated that at environmental temperatures close to the desired house temperature (20 to 25°C) and at high levels of relative humidity outside, the minimum ventilation should be increased above the levels suggested by ADAS to dispose of sufficient levels of moisture.

1.4.1.2 Supply of Minimum Ventilation

Minimum ventilation is supplied under conditions where temperatures are low and the system would also operate more often when birds are young (chicks). The minimum ventilation should therefore be introduced over the entire building as evenly as possible and directed away from the birds. This is achieved by speed control of fans or step control where certain minimum fans are operated intermittently.

When using conventional side inlets with negative pressure fans, the inlets should be adjusted to such an extent that a negative pressure is maintained to ensure that air speed at the inlets is in the region of 250 to 300 m/min. These inlets should be small and evenly distributed throughout the building, directing air away from the birds.

Fan jet and side wall inlets are used 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 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.

1.4.2 Maximum Ventilation

Once outside temperatures exceed the required temperature within the building, increasing amount of ventilation needs to be applied to remove the heat build up in the building. The maximum ventilation rate required is therefore based on the highest expected body mass in the building (metabolic heat produced by the birds) as well the location of the farm and the amount of insulation (heat entering the building from outside).

Example of fans in gable end of the building (Longitudinal Ventilation) or mounted on the side walls (Cross Ventilation)

Under conditions of reasonably well insulated buildings the following formula proposed by Agriculture Development and Advisory Service (ADAS) in the United Kingdom may be used to calculate the maximum ventilation requirement for broilers:

In very hot climatic conditions the following formula is proposed:

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

ALW = average live weight in kg

For broilers this requirement per bird would depend on the age (body weight) of the birds as they grow from day old weight to the slaughter weight. Broilers weighing 2.0 kg the maximum ventilation required would be in the order of 6.0 m^3/hour/kg or 12.0 m^3/hour/bird when using this formula.

Ventilation and control thereof may be obtained by various types of fans and controllers.

1.4.3 Intermediate Ventilation

Between the required minimum and maximum ventilation different rates of ventilation would be required, depending on temperature difference between inside and outside the building as well the age (body weight) of birds.

The amount of intermediate ventilation is achieved 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. This method of control is used when use is made of 3 phase electrically driven fans with no speed control. The temperature differential between steps would normally be in the order of 0.5 to 1.0 °C.

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. As the temperature increases, the fans would operate at increased speed and so remove more heat from the building.

1.4.4 Wind Chill

Under conditions of high environmental temperature it is advantageous to use the wind chill of air moving over the birds to assist in maintaining a more comfortable sensible heat albeit that house temperatures are 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 in Table 1.6.

Table 1.6: 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 therefore be considered. It should also be noted that at temperatures closer to body temperature the effect of wind chill reduces.

For chicks the air speed should be minimal (<0.25m/sec) as the effect of air moving over younger stock is larger compared to when moving over older stock as illustrated in Table 1.6.

Under normal temperature conditions with more mature stock, the air speed should be (between 0.5 and 1 m/sec) when temperature is close to the comfort zone. Under high temperature conditions, the air speed should exceed 1 m/sec to a maximum of around 2 m/sec to make use of wind chill.

Management of the ventilation system should insure that the air speed over broilers remains within these limits. In longitudinal ventilated buildings young stock could easily be chilled by moving air over the birds at higher than acceptable speeds. The temperature of the building would be recorded as being normal but due to the wind chill effect of air movement, the birds will "feel" colder. Birds then lie down, do not feed normally and growth will be affected negatively.

Note that the air speed referred to is the speed of air over the birds and not the air speed at the inlets.

1.5 Cooling of Broiler Sheds

In relatively dry climates cooling of incoming air through evaporation of water (adiabatic cooling) is an inexpensive yet effective way to reduce temperatures. Effective cooling systems will reduce the air temperature to within 85% of the difference between dry and wet bulb temperature.

Data on the psychrometric chart would indicate that if outside environmental conditions are 40°C dry bulb and 25°C wet bulb the relative humidity is 30% and the air contains in the order of 14 g of water per kilogram of dry air. If sufficient water can be evaporated into the air for the water content of the air to increase to 18 g per kilogram of dry air, the relative humidity increases to 75% and the dry bulb temperature reduces to 28°C. So it is possible through evaporative cooling of air to reduce the air temperature in this case from 40°C to 28°C or 80% of the difference between the wet and dry bulb temperature.

Evaporative cooling 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 epithelial of 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.

1.5.1 High Pressure Fogging

In high pressure fogging systems water is turned into a fine mist trough a high pressure pump and spray 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).

High pressure fogging

These systems are popular in open sided houses but may also be used in closed houses. The nozzles are placed in a plenum chamber at the inlet area outside the building or close to the inlets, inside the building. Dripping nozzles should be avoided in litter houses as this will result in wet litter.

The system should switch off at a relative humidity of 75%.

1.5.2 Wet Pad Systems

In these systems air is drawn over wet perforated pads in which the water is allowed to evaporate. This system is generally used in negative pressure ventilated sheds.

Cool pads installed with a rack and pinion controlled air inlet

Water is pumped form 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 100 to 120 m/min is generally recommended for adequate cooling and the system should switch of at a relative humidity in the building of 75%.

1.6 Feeder Equipment

Whatever feed system is used, it should provide the birds easy access to good quality feed in the form that has been delivered to the farm. This means that during transport, storage and dispensing into the poultry shed, the feed should remain in the form delivered (crumbles or pellets) and contamination and growth of micro-organisms must be prevented. Temperature and humidity may damage feed quality. Micro-organisms grow easily in hot humid conditions, especially when condensation occurs in the feed silo.

Table 1.7 presents proposed feeder space that should be applied, but manufacturer specification and the particular application should also be considered.

Table 1.7: Suggested feed space for broiler rearing

Application	Unit	Space
Broilers		
Chick feeders (φ 35 cm)	Chicks/feeder	100 – 150
Day old to slaughter (φ 35 cm)	Birds/feeder	60 – 65
Day old the slaughter (Trough)	Birds/meter	80 – 85

Feed space requirement of broilers will vary in accordance with:

- Age of the birds. Young chicks are confined to small areas commonly referred to as brooder areas in which feeders are concentrated to ensure that small chicks find the feeders easily. As birds age and grow more feed space is required.
- Stocking density. Although the space per bird required may not increase with increased stocking density, the increased numbers of birds in the poultry shed increases the amount of feeders required in the shed.
- Feeder type. Since 20% more birds are able to feed from a circular trough at the same time (shape of bird fitting circular feeder), feeder space for round feeders is less compared to trough feeders, when measured in linear terms.

No fixed rules can be applied for feeding space but Table 1.7 indicates the normal acceptable limits and may be used as a guide. It is advisable that feeder type (manufacturer specifications) and stocking density be taken into account.

1.6.1 Feed Supply

Feed supply would be in bags for smaller farms and in bulk delivery to larger complexes.

With bag supply, sufficient storage needs to be provided for, either in each building or in a central feed store, the size of which would depend on the frequency and reliability of delivery.

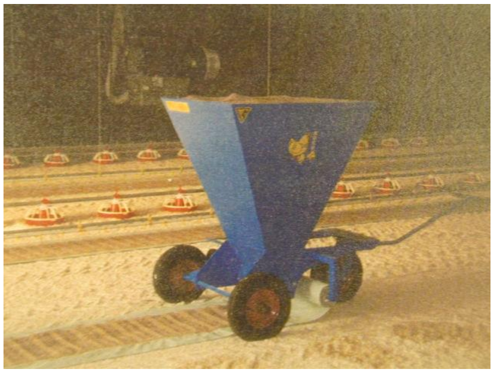
If feed is to be purchased in bulk, the feed bins should allow for sufficient storage which will ensure that feed is never depleted. The dependability of feed supply as well as usage for a given period should be used in calculating storage capacity.

The feed silos should be able to be cleaned easily and preferably two bins rather than one large bin should be available. This will enable easier management of feed changes at the correct time.

Double feed bins make feed management easier

1.6.2 Chick Feeders

Day old chick feeders may consist of plastic feeder trays to allow chicks easy access to fresh feed. These feeders are gradually replaced by the normal feeders during the first 5 to 10 days. Paper strips under the feeder lines under the drinker lines with small amounts of feed spread on the paper are also used. This encourages chicks to find the drinker system.



Trolley used for putting down paper and feed

1.6.3 Manual Feeders

In smaller operations a manual feeding system may be installed, utilizing either open troughs or tube feeders which hold a reasonable reservoir of feed.

Tubular feeders with a round base and which are suspended on nylon cords (by which the feeder height may also be adjusted) from the roof are the most popular type of manual feeder for broiler growing. They are by far less costly compared to automated feeders but are labour intensive.

Manual tube feeders

If not managed properly feed wastage may result due to wastage while filling the feeders as well as incorrect height adjustment of feed within the feed base.

Filling of feed is usually by transferring feed from a feed cart or barrow to the feeder by means of a scoop or small bucket. This is where most feed wastage occurs.

1.6.4 Chain Feeders

A chain feeder system consists of a flat chain being drawn through a feed hopper and feed is then dragged through an open fed trough. The feeder height is adjusted at multiple points and such feeders have to be dismantled for cleaning the building. Chain feeders take longer to distribute feed and feed separation often occurs.

If managed poorly chain feeders are prone to feed wastage. Feed level is adjusted very easily at the feed hopper.

Chain feeders create barriers in the building and bruising and leg damage are more noticeable on chain systems. Breakages are easy to repair and these feeders are generally less costly.

Example of chain and pan feeder systems

1.6.5 Pan Feeders

Although more costly, automated pan feeders become more popular as they provide fresher and cleaner feed and they also do not form a barrier as opposed to the less costly chain feeder system.

Pan feeders consist of an auger pipe from which round pans are suspended into which the auger drops the feed. These systems are suspended from the roof and are easily winched out of the way for cleaning and height is adjusted very easily. The feed levels within the system require each feeder to be adjusted.

Pan feeders allow chicks easy access to feed as chicks are able to climb into the feeder when kept on the floor at day old.

It is a closed system with each feeder being replenished from the auger pipe. When breakages occur they are more difficult to repair and generally these feeders are more costly.

1.7 Drinker Equipment

Clean, fresh and cool water should be freely available at all times to broilers. The water supply system should be kept closed to dust and algae growth. It is essential that sufficient storage capacity is available for maximum bird demand and also for the time of washing down and cleaning the poultry sheds.

1.7.1 Drinker Space Requirement

Although no set rules can be laid down for drinker space required the data in Table 1.8 can be used as a guide for different conditions and applications. It is advisable that drinker type (manufacturer specifications) and stocking density be taken into account

Table 1.8: Drinker space requirement for broilers

Application	Unit	Space
Broilers		
Chick drinker (fonts)	Chicks/drinker	100 – 150
Day old to slaughter (φ 35 cm)	Birds/drinker	120 – 130
Nipple drinkers	Birds/nipple	11 – 15

Water space requirement will depend on the type of drinker as well as the application. Drinker space requirement would therefore depend on:

- Type of drinker - due to more space available around a round drinker the linear space per bird for Bell shaped drinkers would be less compared to trough drinkers
- Age of the birds - older birds are provided with more space per bird than young (smaller) birds
- In hot environmental conditions, drinker space should be increased
- Stocking density increases numbers of birds in the poultry shed and the amount of drinkers required in the shed should be increased as well.

1.7.2 Chick Drinkers

Manual chick founts are often used during the first 5 to 10 days to ensure adequate supply of water and to concentrate drinker space within the brooding area.

Although they are labour intensive they ensure that water is readily available within the brooding area, especially when automated systems cannot be concentrated and increased in numbers inside the confined area.

The change over from chick founts should be gradual over two to three days.

1.7.3 Bell Type Drinkers

Bell drinkers supply "open water" which requires regular cleaning and adjustment to avoid spillage and contamination. Height of water in the trough should be half full to avoid spillage. Some types of Bell drinkers are ballasted to reduce swinging and spillage.

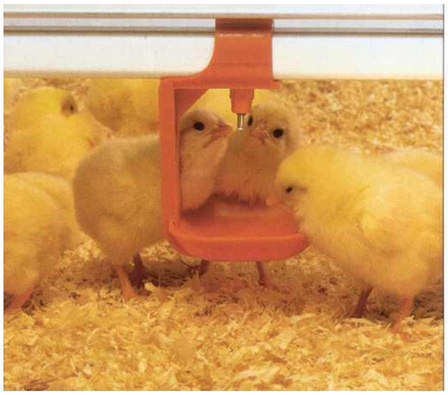
Bell type drinker

Bell drinkers have high trough lips and create difficult access for day old chicks. Additional chick fonts should be provided for the first 4 to 10 days.

1.7.4 Nipple Drinkers

Nipple drinkers have become popular as they are closed systems requiring less maintenance and if managed correctly result in very little wastage and spillage. This results in better litter quality with consequent improvement in leg abnormalities, hock burns and breast blisters.

Some modern nipples do not require a drip cup and are suitable for use in day old chicks as well, provided the light intensity for the first 3 to 4 days is very bright (above 30 lux). Other types of nipples are supplied with drip cups.

Nipple drinkers without and with drip cups

Nipple drinker lines are to be flushed out regularly with a de-scaling agent to avoid build-up of mineral deposits in the nipples.

1.7.5 Cup Drinkers

Cup drinkers are open drinkers and become contaminated and dirty if not managed properly. They were popular as a replacement for Bell drinkers but have become less so due to the availability of more modern nipple drinker systems.

Example of a cup drinker system

Cup drinkers do however have the advantage over nipple drinkers in that chicks adapt to the open drinker systems more readily.

1.8 Heating Equipment

The day old broiler chick hatched from an incubator where the temperature was 37°C and relative humidity 60%. The normal body temperature of chickens 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. The chick is unable to produce sufficient heat through the normal metabolic processes to maintain body temperature. 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.

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

Various brooding methods are applied to supply the correct environment and temperature 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.

1.8.1 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.

1.8.2 Whole House and 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.

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 totally 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.

1.8.3 Heating Systems

Various types of heaters are available by which broiler houses are heated.

1.8.3.1 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 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.



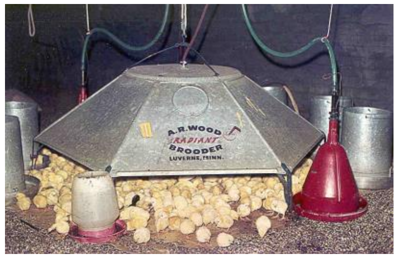
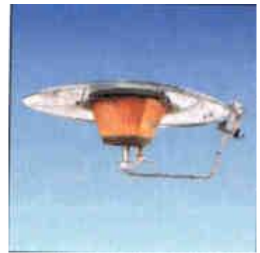
1.8.3.2 Open Flame Heaters

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

1.8.3.3 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 than 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.

1.9 Stocking Densities

The area of floor space to be supplied will depend on age at which birds are to be processed, climate and season as well as type of housing. No stocking density regulations apply in South Africa but the South African Poultry Association Code of Practice states that "chickens raised in floor pens shall have enough freedom of movement to be able to stand normally, turn around and stretch their wings without difficulty". The Code of Practice also provides some guide in respect of broiler stocking densities to be applied.

With well designed houses and equipment in open sided houses a maximum density of 15 to 17 birds per m^2 may be applied which at 1.9 kg final live mass would equate to 28 to 34 kg per m^2. In properly designed fan ventilated buildings which are well managed the density can successfully be increased to 21 birds per m^2 which equates to 40 kg per m^2 at a final weight of 1.9 kg.

Stocking density has a significant effect on final product quality and performance. Although increased density has the advantage of increased number of birds reared, it does place an increase on environmental requirement, which if not managed correctly, could easily result in reduced production performance and profitability.

The effects of increasing stocking density include:

- Growth rate will be reduced, especially towards the end of the growing period
- Mortality is liable to increase due to increased pecking and cull percentage
- Poor litter conditions and consequent effect on downgrading due to breast blisters and leg problems will be created, especially if ventilation is not managed correctly
- Poor feathering resulting in increased bruising and scratching and therefore downgrading may be forthcoming
- Flock uniformity will deteriorate
- Meat quality may also be affected

The optimum stocking density would therefore depend on particular circumstances that prevail.

2 Brooding Management

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 in the brooding area.

To utilize the genetic potential of modern broilers, it is essential to provide a chick environment that will give them a good start. The key to successful growing of broilers starts in obtaining good weight and uniformity and low mortality at 7 days of age. The target should be to quadruple the chick weight at day old by seven days of age. Therefore if the average chick weight is 42 gram, then by 7 days the body weight should be 168 gram (4 x 42). This will only be achieved by starting with good quality day old chicks and rearing the chick under well managed conditions.

The building should have been well prepared and operating at the required temperature prior to chick arrival. Humidity and access to fresh feed and clean water are equally important.

2.1 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 the case of large farms which are operated on an all-in, all-out replacement cycle.

This is also the time in which nipple drinker systems are to be de-scaled and flushed out.

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 arrival 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 40 to 50 chicks per m^2 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 (double up from the normal density of 18 to 20 birds per m^2).

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 general rule is that the feeders and drinkers should be evenly spread out and also chicks would normally be kept away from the colder parts such as close to side walls.

The brooding area should be warm 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 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 should be checked and chick fonts (if used) filled.

2.2 Chick Placement and Quality

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 and this could even occur during transport of the chicks to the farm. The floor requires special attention as much heat is lost trough 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.

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 temperature

Broiler chicks should preferably arrive early morning but not later than noon. 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.

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

At least a random number of (if not all) boxes should be counted to verify numbers of chicks with the supplier. The supply hatchery should be notified as soon as possible of any abnormal findings.

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 33.5 grams (from 52 gram eggs)
- Are not dehydrated and craving for water
- Stand up well on normal surfaces
- Are lively and alert
- Should not be wet and covered with hatch debris

Off loading and placement of chicks should not be delayed and chicks are to be placed into the surrounds or 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 chicks should be placed on rough paper below nipple lines. This will ensure that chicks find the nipple drinkers as soon as possible.

The chicks are placed by gently tipping the chick boxes and spreading the load evenly over the brooding area.

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

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, that they are remaining within the confined brooding area, while making the necessary finer adjustment to temperature and ventilation.

2.3 Brooding Chicks

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 in the brooding area and likewise 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.

The objective during the brooding period is to:

- Achieve maximum weight gain during the first week. The weight should quadruple during the first 7 days (that is if average chick weight is 40 then first week weight should be 160g)
- Ensure that mortality during the first week is below 0.5% and below 1% at 14 days
- Achieve good flock uniformity and even if parent flock is young (producing chicks of 35 to 36g at day-old) very few chicks should be culled out at 14 days (<0.25%).

The brooding area is increased gradually from the 3rd day until birds have access to the entire building from 10 to 14 days of age, depending on the type of house and environmental conditions.

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. 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 Table 1.4 provides a rough guide of what is to be achieved. 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 or huddle at heat source or in clumps in certain areas
- 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 the ideal is to ensure a relative humidity level in the order of 50 to 65%.

Cold chicks huddling compared to warm active chicks that are evenly spread

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.

They also have the tendency to have been overstressed during the incubation process and extra emphasis should be given to especially 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.

2.4 Ventilation and Humidity

During the brooding stage of broiler 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 is 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.

A Relative Humidity (RH) of between 50 and 65% is desirable during the brooding period.

2.4.1 Brooding Ventilation in Natural Ventilated Buildings

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 through a vent in the roof. 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.

2.4.2 Brooding Ventilation in Fan Ventilated Buildings

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. An example of such schedule is presented in Table 2.1 and such a table could then be used to calculate the minimum ventilation and fan setting for a particular circumstance.

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.

Table 2.1: Example of calculating the minimum ventilation for broilers

Age	Live Mass (g)	Min Ventilation (m^3/kg/hour)
1	50	1.22
2	61	1.16
3	76	1.10
4	93	1.04
5	112	1.00
6	135	0.95
7	160	0.91
8	186	0.87
9	219	0.84
10	253	0.81
11	290	0.78
12	330	0.76
13	373	0.74
14	419	0.72
15	468	0.70
16	519	0.68
17	574	0.66
18	631	0.65
19	691	0.63
20	753	0.62
21	818	0.61
22	885	0.59
23	955	0.58
24	1027	0.57
25	1102	0.56
26	1178	0.55
27	1256	0.54
28	1336	0.54
29	1418	0.53
30	1501	0.52
31	1584	0.51
32	1571	0.51
33	1757	0.50
34	1845	0.49
35	1933	0.49

2.5 Feed Management of Chicks

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 form the normal feeder system.

Check weights at the end of the first week are to serve as guide whether feeding and brooding technique is good. The goal is to quadruple the chick weight by 7 days. That is if the average chick weight is 42 g then by 7 days the average weight should be 168 g.

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.

2.6 Water Management of Chicks

Chicks should have access to clean fresh water at all times. Chick fonts are cleaned daily and replenished with fresh water. The water level in Bell drinkers should not be excessively high 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° angel with the beak is normally recommended by nipple drinker suppliers. With nipple and cup drinkers, water pressure is of extreme importance and supplier recommendations should be incorporated into schedules and checklists that remind staff to make these adjustments timeously. For chicks the water pressure would normally be lower compared to older broilers and the water pressure therefore needs to be adjusted with age.

Where chick fonts 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

2.7 Light Management of Chicks

Broiler chicks are subjected to a high light intensity for the first couple of days to ensure that feed and water is found readily. Thereafter the light intensity is reduced to keep birds calm and reduce activity.

A photoperiod of 24 hours will also be applied initially.

A light program as suggested by the chick hatchery should be placed in the house together with a check to ensure that the program is adjusted at the time indicated.

3 Grow-out Management

The grow-out period embraces the period from when supplementary heating is no longer required and birds are producing sufficient heat through metabolic processes to maintain the required environmental temperature in reasonably well insulated buildings. It obviously also covers the period of change from brooding and chick systems to systems and equipment suited for more mature stock.

During growout, environmental control is of key importance and daily routine checks must be done to ensure and monitor flock progress and provide for early warning of possible problems that may be developing. Birds should have free access to fresh feed and clean water.

The objective is to achieve optimum weight gain without feed wastage to ensure low feed conversion ratios (FCR). This will only be possible under good management and control of equipment and environmental conditions and keeping the birds healthy.

3.1 Feed Management

Broilers are normally fed *ad lib* and the feed should be fresh and palatable at all times whatever the feeding system.

3.1.1 Broiler Feeds

Broiler feed from a reputable feed company, preferably in crumb and pellet form, should be used in accordance with supplier recommendations. Accurate estimation of quantities is required to ensure timeous changeover of feed. Feeding incorrect feed at incorrect times will be costly.

Broiler feeds should be formulated to ensure the correct balance between energy, amino acids, minerals and vitamins. The composition of the feed will have a significant effect on performance and profitability as feed cost would normally represent 70 to 80 percent of the farm production cost. Feeds sourced from reputably feed companies should be used and continuous discussion with technical representatives from such companies should be held to ensure correct application of the appropriate feeds.

Various feeds would be used, each of which are designed to maximize performance during the specific period of growth. Most often a four phase feeding regime would be used, consisting of a Pre-starter fed from 0 to 7 days, a Starter fed from 8 to 14 days, a Grower fed from 15 to 30 days followed by a Finisher to slaughter. Most feed companies would however have their own recipes and recommendations which have been designed and adapted to suit local conditions.

3.1.2 Managing the Feeder System

Feeder height and feed levels within the feeding system should be adjusted regularly. Normally a height of shoulder level (middle of the wings) would be recommended with lower levels during the initial stages to allow chicks to climb into the feeders. Feed height should be set according to manufacturer recommendation to prevent feed wastage without limiting access to feed. Feeder systems would normally consist of manual feeders, chain feeders or pan feeders.

3.1.2.1 Manual Feeders

Whatever manual feed system is used, feed should be kept fresh and be readily available at all times to the birds. Open troughs will require more regular replenishment compared to tubular feeders.

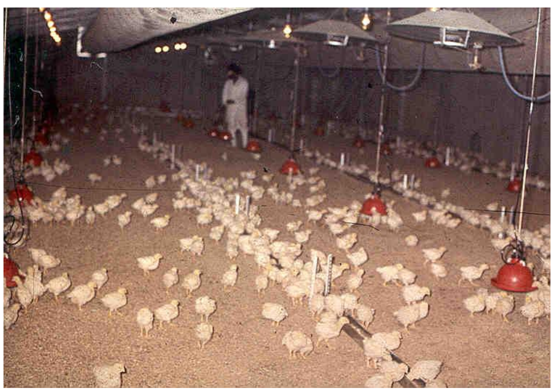
Special attention should be given to when feed is transferred from the feed cart/barrow into the feeder itself. This is the point where much feed wastage could occur. The transfer bucket should have a narrow chute which ensures that feed flows into the feeder without any wastage.

When tube feeders are being used, it is advisable to shake the feeders from time to time to ensure that feed is flowing into the feeder pan below. Excessive shaking of the feeders will result in overfilling of the feeder pan and consequent feed wastage. The gap between the feeder pan and tube should preferably be set in such a way that feed flows by itself but not resulting in feed wastage.

The feeders should be allowed to be emptied from time to time to ensure that feed remains fresh and that the fine material is consumed as well.

3.1.2.2 Chain Feeders

Chain feeder systems would normally consist of a bulk feed tank, cross-auger, feed hopper with drive unit and the troughs and chain. A time clock of some sort will activate the system at set times and stop the system when the chain has completed a full circle.



Example of a chain feeder system

High and low level sensors in the feed hopper will activate and stop the cross auger. In managing the system the aspects to bear in mind include:

- The sensors controlling the cross auger should be set in such a way that excessive feed is not augured into the feed hopper. It should also not be set too low, causing the hopper to run without feed and the down pipe from the cross auger should not interfere with the sensors.
- The plate controlling feed height on the chain should be set so that the feed level is about 10 mm deep on the chain. This could be higher in the young chick stage

- Ensure that corner wheel plates are in place. If not, injuries to toes will occur.
- Continually set feeder height so that level of lip of feed trough is just lower than shoulders. For young chicks this is lower, allowing chicks to climb into the trough.
- Ensure that there is a fixed program stipulating feeding time at the various stages of development. Feeding times will vary according to age and rate of feeding as well as environmental temperatures. Broilers are normally fed on an ad lib basis and feeding times should be set in such a manner that the feed chain is never depleted of feed.
- Ensure that the chain is at the correct tension according to manufacturer recommendation.

3.1.2.3 Pan Feeders

The pan feeder systems would consist of a bulk feed tank, cross auger and multiple lines of feed pans suspended from a pipe in which an auger conveys feed from the feed hopper. High and low sensors are placed in the feed hopper furthest from the feed tank and the cross auger fills the system from one side. A motor situated at the end of each line drive the auger in the tube and conveys feed from the feed hopper, dropping it into feed pans suspended below the pipe. The feed pan furthest from the feed hopper is equipped with low and high level sensors.

Example of a pan feeder system

The system would be controlled by a time clock in the control panel which activates the system at set times. The sensor in the pan furthest from the feed hopper stops the particular feeder.

In managing the system the aspects to bear in mind include: -

- The sensor controlling the cross auger must be set in such a way that it activates the auger prior to the hoppers closer to the feed bin being depleted of feed. The feed in this hopper should be lower. The down pipe from the cross auger should not interfere with the sensors

- The amount of feed being dropped into the pans is adjustable. Increase feed levels during the chick stage but decrease feed levels during growing period and eliminate wastage
- Continually set feeder height so that level of lip of feed trough is at just lower than should height. For young stock this is set lower, allowing chicks to climb into the pan
- Ensure that feed levels in the feed pans at the end of the lines which control the system, are set at lower levels than the rest
- Ensure that from time to the birds are forced to consume the fine feed material as well but not to such an extent that feed intake is affected materially.

3.1.3 Determining Feed Consumption

It is essential to know the feed consumption to ensure that birds are feeding normally. Should feed weighing equipment such as dump scales or load cells not be available, then feed usage should at least be estimated volumetrically.

3.1.3.1 Volumetric Estimation

If the volumetric weight (kg/m^3) of the feed is known, the feed stock in the bin may be estimated. By subtracting the feed stock form the sum total of the opening stock and any feed delivered in the time period, the feed intake within that period may be estimated.

The volume of a round bulk tank is calculated by adding the

Volume of the cone part = height of the cone x 1/3 of the area of the base
to
Volume of the cylindrical part = area of the base x height
where
Area of the base = (Diameter of the tank)^2 x 0.7854

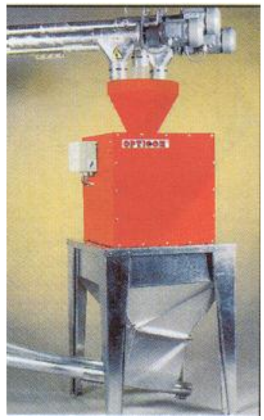
The installation of double feed tanks will assist further in that feed is then allowed to be emptied from the bin providing for correction of interim calculation and estimation.

3.1.3.2 Dump Scales

Dump scales weigh off a fixed amount of feed at a time (20kg tips) into a mini bin from where the feed is conveyed into the feeding system in the poultry shed.

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

These systems are fairly accurate but should be assize regularly to ensure correctness. A weight equal to the tip required is used for test weighing from time to time.



3.1.3.3 Load Cells

Load cells are placed under the bulk feed bin for accurate weighing of the feed within the feed bin. This information may be recorded manually or electronically into a data base system for accurate determination of feed intake within a given period. It is the most costly but most accurate measure of feed intake and may even provide for calculation of feed intake on an ongoing basis. If linked to frequent weighing of birds, the progress of the flock is monitored very closely and potential problems may be corrected timeously.

Load cells under the bulk feed bin

3.2 Water Management

Broilers should have access to clean fresh water at all times. Any wet patches on floor systems should be removed and the cause of leaking systems should be attended to immediately**.** **P**oor litter quality enhances the incidence of hock burn and poor carcass quality and also increases the production of ammonia in the building.

The various systems such as Chick Fonts, Nipple drinkers and Cup Drinkers Bell Drinkers have their specific setting and management requirement. Manufacturer instructions especially in the case of nipple and cup drinker water pressure and height should be used.

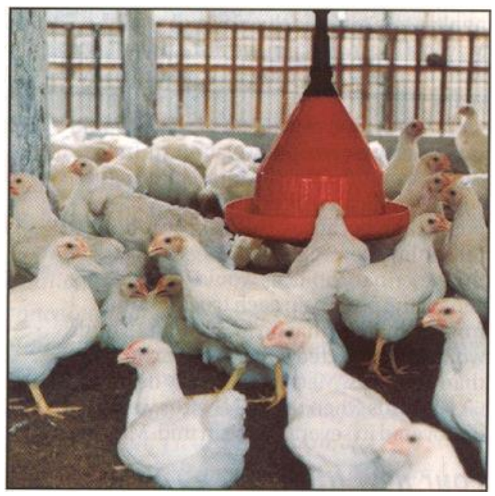
Water consumption on a daily basis can provide early warning signs of potential problems. Water flow is measured by water meters which are read at a particular time of the day and the previous reading is subtracted to calculate the water intake within the period. When divided by the number of birds, the intake per bird on a daily basis may be calculated. As a rule the water consumption is roughly 1.8 times the feed intake and will obviously change when temperature is either high or low.

The cause of leaking water systems could be:-

- Dirty water as a result of poor filters and water quality
- Faulty automatic chick founts
- Incorrect water pressure
- Incorrect height of system resulting in water being wasted
- Leaking pipes
- Missing drip cups on systems requiring such cups
- Mineral deposits caused by improper treatment of water with high mineral content

3.2.1 Managing Bell Shaped Drinkers

Bell-type drinkers are to be cleaned at least every second day and water height in the drinker adjusted to not more than half full.



Typical Bell drinker

Drinker height should be regularly adjusted to ensure that the lip of the drinkers is at shoulder height of birds. If too high, birds experience difficulty to reach water and if too low, spillage will occur.

Where ballasted bell-shaped drinkers are used, the ballast should be filled to reduce swinging and water spillage.

3.2.2 Managing Nipple and Cup Drinkers

With nipple and drinker cup systems, water pressure and height of drinker system is of importance and should be set in accordance with manufacturer recommendations. Most of the systems would start off with low pressure increasing as the birds age. It is important to ensure that manufacturer recommendations are followed to ensure correct water intake by the stock.

Nipple drinkers

Nipple height should be set in such a manner that birds drink with beaks at a 30° angel to the nipple.

To assist with the regular adjustment of water pressure and drinker height, it is always good practice to have such settings incorporated into setting and environmental control schedules. This ensures standard adjustment and finer settings are then made to suite particular conditions.

3.2.3 Medication through the Drinkers

Medication or the addition of other substances (vaccines) may be required from time to time. The water consumption must be known to ensure that the medicament is administered within the required period and at the required rate. This is of special importance when applying water vaccination as vaccines need to be administered at the correct dosage and within a specific period of time.

If the daily rate of water intake is not known then Table 1.2 may be used as a guide but preferably the actual intake at the time should be known. The medication is then applied via a water dosing system or by making use of header tanks into which the medicament is added.

The drinker system should also be cleaned out (flushed) to ensure that no contaminants or residue is present which may interfere with the vaccine or medicament.

3.3 Light Management

Under normal conditions of broiler production, continuous light is applied to maximize daily weight gain. Such light programs consist of a long continuous period of light (23 hours) followed by a short dark period (1 hour) in the 24 hour cycle. The short dark period is intended to accustom birds to darkness in the event of a power failure.

Following the high light intensity during brooding (20 to 25 lux), the light intensity in broilers should be reduced gradually to keep the birds calm yet not affecting their eating habits. Normally by three weeks of age (21 days) the intensity should be in the range of 5 to 10 lux.

This is often a problem in open sided buildings and shade cloth on the side of the building will assist in keeping birds less active. Direct sunlight should be eliminated from open sided buildings.

Under certain conditions modified growth programs incorporating light are used to reduce excessive growth between 7 and 20 days and to accelerate growth thereafter. No single program can be used for varying circumstances and it is best to design such programs around particular conditions of housing, general health, feed and management.

3.4 Environmental Control

The objective of ventilation during growout is to ensure removal of heat, dust and waste products such as carbon dioxide, ammonia and moisture and to introduce sufficient quantities of fresh air, without allowing the temperature inside the building to drop below the comfort zone of the birds. Temperature conditions would therefore normally determine the amount of ventilation that is to be applied but finer adjustment should be made, taking into account other environmental conditions in the building. Poor ventilation could easily result in respiratory problems due to excessive dust, ammonia and other waste products and insufficient levels of oxygen, which will enhance the susceptibility to conditions such as ascites.

3.4.1 Managing Ventilation in Open Sided Buildings

The design and principles on which open sided houses function and operate has been explained is the section on housing. In this type of building less control is possible and side curtains are normally used to control air movement through the building.

Principles of managing broilers in open sided houses include:

- The stack effect of air dynamics is used to control minimum ventilation. This is achieved by closing side curtains leaving minimum opening to allow for some air movement and the warm air to rise to the top. The extent of opening the side curtains would depend on age of birds, environmental temperature as well as wind pressure
- As temperatures increase, side curtains are opened more, the extent of which again would depend on amount of wind, wind direction, environmental temperature and age of the birds
- Under low wind pressure, side curtains will be opened evenly on both sides but under high wind pressure, the wind side will be opened less than the opposite side
- Under low temperature conditions and especially for young chicks, the wind should be diverted away from the birds
- As birds age the wind over the birds may be increased, especially so under high temperature conditions.

3.4.2 Managing Ventilation in Closed buildings

The ventilation requirement in broiler rearing houses equipped with fans is constantly changing due to environmental effects and age of the birds. The rate of ventilation is normally activated by the temperature differential between set point required and the actual temperature in the building and will pass through stages of ventilation or speed control of fans to maximum ventilation at a differential of 5 to 7°C above the set point. Maximum ventilation is therefore reached at a temperature of 5 to 7°C above set point.

The design and description of fan ventilated systems have been noted in the section on housing.

Some aspects to be noted in managing the ventilation of poultry sheds include:

- An adequate negative pressure must be maintained to ensure proper mixing of air in the building and this is generally achieved when the air speed at the inlet area is maintained at 300 to 350 meters per minute. For young chicks this is reduced to 200 meter per minute and for older birds under high temperature conditions, the air speed may be increased to induce cooling through the wind chill factor
- Air speed over chicks and under conditions close to the set point should be kept below 0.5 m/sec. This could be increased to 1.0 m/sec for older birds when temperatures are slightly above the set point. Under high environmental temperature, an air speed of 2.0 m/sec will produce a wind chill factor of around 10 °C when birds are 4 to 6 weeks of age
- Wind chill effect reduces at temperatures close to body temperature
- 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. Once wet litter conditions appear as a result of under ventilation (or too cold conditions) it normally will be too late to correct4 4
- Under cold weather conditions, the cold incoming air should be diverted away from the birds

- As fans increase speed or more fans operate, inlet area must be increased simultaneously, maintaining the desired negative pressure or air inlet speed
- Fan shutters are to be properly maintained as adjacent fans will be short circuited if shutters do not close properly when fans are off
- Often individual fans are equipped with light proofing cassettes. These should be kept clean as dust accumulation will impair air flow
- Fan blades are also to be kept clean as dust accumulation will impair the capacity of the fan
- Do not allow doors, especially large entrance doors to stand open as this negates the negative pressure and results in improper ventilation in the shed (dead spots). Ensure that the systems are tested and that all shutters and inlets open in accordance with the ventilation program and design of the system
- Properly designed fan ventilated houses will normally produce very good results with good maintenance and management control. A poor understanding of the system however often results in poor performance due to incorrect setting and operation.

3.4.3 Evaporative Cooling of Broiler Sheds

3.4.3.1 Managing Micro Mist Systems

Most Micro mist systems operate at high pressure (4 to 5 bar) through fine nozzles. This forms a fine mist and through the process of vaporisation of the water, cooling of the air is achieved. Because of the very fine nozzles used, water quality is critical and most systems would have their own built-in water treatment mechanism. Where water quality is suspect it may be advisable to assist with larger sand filters and water treatment units.

The booster pump ensures adequate water supply to the system and the high-pressure pump ensures the high water pressure, which will create the mist through the nozzles. If pressure and water supply is inadequate, the cooling ability of the system will be influenced.

The point at which the system is operated should not be too low and is generally set at 30°C. The system should not be allowed to operate continuously and should switch off after a given time or sufficient drop in temperature. If not it could result in the system causing manure to become wet, especially with floor systems as the spray nozzles are situated in the building. The systems should also be switched off at relative humidity of 75%.

The units should undergo a major service at the start of summer and blocked nozzles are cleaned by leaving overnight in an acidic solution such as citric acid or vinegar.

3.4.3.2 Managing Wet Pad Systems

Cool pads operate on the basis that water is pumped from a sump into a trough at the top of the pad equipped with holes through which the water wets the pad. The water flows from the trough onto the pad and any surplus water overflows into the trough at the bottom, from where it flows back into the sump. An amount of water should always be allowed to overflow to ensure that the pad is continuously being flushed. This is achieved by an adjustment valve. Air drawn through the pad then vaporizes the water from the pad, causing the air to be cooled.

Insufficient wetting of the pad results in poor cooling and possible reasons include:

- Faulty pump
- Incorrect setting of control valve causing dry areas on the pad
- Blocked holes in the trough above the pad resulting in dry areas on the pad
- Blocked pad (dust and calcified mineral deposit)

Good water quality (low in dissolved solids) is therefore important in these systems and hard water should preferably be treated. At the end of the cycle, especially during summer, the sump should be drained and filled with fresh water to eliminate build up of minerals in the water. The pads should be regularly rinsed with a light acidic solution to dissolve and flush out any mineral deposit.

3.5 Routine Checks and Records

During the growing out period certain regular routine procedures need to be carried out and they include:

- Adjustment of ventilation and all other settings in accordance with standard programs
- Checking and adjustment of feeders and drinkers for correct level of feed and water with no wastage and equipment adjusted to and set at correct height
- Keeping light system clean and adjustment of lights and intensity to required levels
- Performing weekly test weighing
- Keeping change rooms and showers clean and tidy
- Ensuring that standard programs such as vaccination, weighing and blood sampling are being attended to and adequately supervised
- Recording and calculating feed and water consumption and monitoring this to expected levels
- Thorough inspection of birds and removal and disposal of mortality and removal of cull birds and humane disposal of such birds and recording of the numbers involved

To assist in supervision of labour in this regard it is often advisable to have such standard daily routine schedules placed in the poultry shed and signed off by the responsible person.

Accurate and timeous records are essential for effective application and response to management techniques.

Analysis and interpretation of production performance data are vital in ensuring upgrading and improvement of performance levels. It is essential to continuously assess the effectiveness of nutrition and management practices. Breeding companies and chick suppliers will supply standard performance guides and charts and these together with historical data are to be used as benchmark.

3.5.1 Flock Records

Any basic flock record system would consist of data being recorded on a daily basis which is then used to calculate meaningful data daily, weekly and for the entire crop. Any basic record system would incorporate the following:

- **Placement Statistics** should include the number of chicks placed, origin of chicks, hatch date and time of arrival.
- **Mortality should be recorded** daily and expressed as a percentage of the number placed. This is also cumulated and again expressed as a percentage of the number placed. Daily and cumulative mortality is often plotted on a mortality graph and compared to a standard
- **Feed** quantities and date of feed deliveries for each feed type should be recorded. A check on the daily feed intake will assist in monitoring progress and timeous reaction to optimize flock performance
- **Water** intake should be recorded and checked to standard on the daily basis to monitor progress and to enable timeous and appropriate action to be taken in case of problems. A decline in water intake can be an early indicator of poor feed quality, disease challenge and other stress
- **Body Weight** checks during growout of the flock are essential. A weekly check on the body weight as well as the average gain during the period should be performed. Automatic scales are available but manual weighing of a random sample of birds will suffice. Three small lots of birds (50 to 70 birds per pen and randomly spaced throughout the house) should be cordoned off. All birds within the pens are then weighed. Electronic scales which calculated the average weight of the sample weighed as well as the weight distribution are available
- **FCR** or feed conversion is calculated by dividing the amount of feed used by the body mass
- **Vaccination** should be done as prescribed by a veterinarian. Records should be kept reflecting the date of the vaccination, vaccine type used, batch number of the vaccine as well as a check on the expiry date of the vaccine
- **Environment** checks should be done daily and at least the minimum and maximum temperature should be recorded. This should be evaluated against external temperature

3.5.2 Flock Performance

A standard flock performance evaluation is often used to assist in comparing flock performance within an organisation. This is commonly referred to as the Production Efficiency Factor (PEF) and is calculated by the following:

$$\frac{\text{Liveability x Live weight (kg)}}{\text{Age (days) x FCR}} \text{ x } 100$$

A flock processed at 35 days, with a total cumulative mortality of 5.0% (95% liveability), an average live mass of 1.90 kg and a feed conversion of 1.65 will have the following PEF:

$$\frac{95 \times 1.90}{35 \times 1.65} \times 100 = 312$$

A flock processed at 35 days, with a total cumulative mortality of 7.0% (93% liveability), an average live mass of 1.85 kg and a feed conversion of 1.70 will have the following PEF:

$$\frac{93 \times 1.85}{35 \times 1.70} \times 100 = 289$$

3.6 Growth Modification

Although maximum weight gain is of particular importance in broiler growing, in extreme conditions, such gains could induce reduced liveability, leg problems and metabolic disorders, especially when the growout period is prolonged with the market requiring higher weights. Under such conditions it may be beneficial to consider modifying the growth curve of the flock. This should however be done with a great deal of care and control. These modified programs are more successful when separate sex growing is applied and the flock is more uniform. With separate sex growing there is better control on especially the male growth curves.

Breeders and broiler producers have developed growth modification programs to suit particular conditions and requirements and the principles of modified growth include:

- Managing the average daily gain in the period 5 to 7 days to two to three weeks to less than the maximum daily gain in a manner to particularly develop the heart, lungs, skeleton and immune system
- Daily gain in the subsequent period is managed to a predetermined weight for age profile to achieve a target weight by slaughter age. Compensatory growth is used to accelerate the daily gain, thereby achieving the same final mass at slaughter compared to a normally managed flock
- The particular weight for age profile is determined by sex, final slaughter weight and yield requirement.

Programs need to be developed for particular circumstances and requirements but the following basic principles would apply:

- Do not start restriction programs before 5 days and allow chicks to grow normally
- It is beneficial to have separated sex flocks as males need to be restricted more (12 to 15%) compared to females (8 to 10%)
- When slaughter weight is low (1800 to 1900 g) the amount of reduction in body weight at 14 days would be less compared to when slaughter weights are heavier (2000 to 2100 g)
- Ensure that restriction programs are not too severe or last too long
- Bird activity will change and ventilation and management techniques must cater for this

- Adequate feed and drinker equipment should be available during the period of compensatory growth
- Regular and accurate check weighing is required to monitor progress.

3.6.1 Quantitative Feed Restriction

Quantitative feed restriction programs are based on limiting the daily feed allocation. When applying this method, the following key issues need consideration:

- A high degree of accurate feed measurement is needed and birds have to be weighed more often (2 to 3 times per week). The feed distribution system must be able to allow all birds equal access to feed and feed space and feeding times are therefore critical for success
- Birds will be a lot more active and ventilation systems need to cope with the increased heat generated by the birds
- Increased scratching may develop as a result of the increased activity especially when feeders start running low. It is advantageous to lift feeders when feed is almost depleted
- Litter quality could deteriorate due to excessive water intake and controlling water may be required
- Birds are unlikely to compensate in weight by 35 days if weight depression at 21 days is in excess of 12%

These programs should be developed for particular conditions and analyses of historical data taking into account seasonal, nutritional and other flock variations will be needed to develop a comprehensive and reliable program.

3.6.2 Qualitative Feed Restriction

During the initial period of growth birds are not completely capable of adjusting intake to compensate for lower nutrient content. Reducing the nutrient density during this period is therefore a possible method of reducing growth. Feed companies may therefore develop specific feed formulations for particular conditions but no fixed recipe can be applied. These programs may incorporate altering the feeding times of the Pre-starter, Starter and Grower diets or even the development of completely different diets.

Care should however be taken to ensure that carcass composition is not affected. Diets deficient in nutrients (amino acids) could increase the fat content and decrease meat yield at processing.

Qualitative feed restriction is less popular due to the difficulties experienced in controlling the exact nutrient density.

3.6.3 Altering the Feed Form

Most broilers are fed crumb or pellet feed to achieve maximum growth and feed efficiency. The feeding of feed in mash form reduces growth rate and programs have been developed in which such feed is used to reduce the weight gain.

This method may however prove not to be economical in certain areas (not sufficient reduction in feed price) and the feeding of mash could increase the incidence of pendulous crop.

The technical expertise of the feed supplier should have sufficient knowledge and background to supply and devise programs that may fit particular conditions, especially if the reduction in gain is to be marginally low.

3.6.4 Modified Light Programs

Broilers are generally grown on 23 hours light per day for maximum gain. Research has shown that rearing broilers on less than 23 hours could have benefit and breeders have developed various programs for particular needs and circumstances. These programs consist of a combination of increased and reduced photoperiod during various stages when reduced weight gain and increased weight gain is to be achieved as well as the use of intermittent light programs.

Key issues in modified light programs include:-

- Most breeders have found that day length less than 16 hours has a significant effect on feed intake and live-weight gain. The use of a short day is therefore effective in reducing weight gain in the period 4 to 14 days, following the initial 24 hour period during brooding
- Birds adapt to the reduction in light and will tend to anticipate the dark period and compensate in intake of feed. The effect on feed intake is therefore greater immediately after the light reduction
- Birds benefit from the clear pattern of day and night by having a higher degree of resting and active periods. This has a beneficial influence on bone development.

These programs should be developed by means of an analytical and responsive process using historical flock performance data to make adjustments.

3.7 Managing Heat Stress

The weight gain of broilers will deteriorate at high environmental temperatures due to reduced feed intake. Under extreme heat conditions the following management practices could be considered to overcome part of the effects of high temperatures:-

- Keep birds calm and do not disturb unnecessary
- Vaccinate and work with birds during cooler periods of the day
- Ensure clean fresh and cool water
- Activate feeders more during the cooler part of day
- Eliminate direct sunlight in open houses
- Reduce stocking density
- Use feed in which source of energy is more concentrated (oils and fats rather than carbohydrates)
- Ensure good crumble and pellet quality
- Males are more susceptible to heat stress due to the higher body weight. Separate sex rearing with increased reduction in male stocking densities will help

- Wet the roofs and surrounding areas but take care not to create and exacerbate high relative humidity conditions
- Avoid wet litter and poor housing conditions
- Increase air movement over the birds to increase sensible heat loss (2 to 2.5 m/sec) for birds over 21 days of age. However, avoid such high air speed over younger birds.

3.8 Separate Sex Growing

The requirement for further processed products, boneless meat and consumer demand has increased the need for a more uniform product at the processing plant. Since male and female broiler weights differ significantly, the need for separate sex growing has increased in recent years. When reared separately the larger more efficient males could be used for cut-up and value added products and the slower growing females for the whole birds segment of the market.

The weight spread around a given target weight at processing can be improved by separate sex growing making it more easy for the processing plant to meet consumer demand. From a management point of view, competition in the broiler shed is reduced as the larger and more dominant male broilers are separated from the females and both sexes can be managed more efficiently with regard to feeding, lighting and stocking density.

The sex of some modern broiler chicks can be determined by feather sexing at day old making it relatively easy to distinguish between male and female chicks.

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 birds live. 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 primary wing coverts, which are the small downy feathers covering the base of the primary feather shafts.

To understand the genetic fixing of this it is necessary to understand the genetics of sex determination. Sex is determined by the sex-chromosome known as the Z and W chromosomes in chickens. 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 therefor when linked to the Z chromosome only the Z chromosome will determine gene characteristics carried on that particular chromosome. Males are then identified as having ZZ chromosomes whilst females have ZW chromosomes.

The gene which determines the rate of feather growth in the chicken is carried on the Z chromosome.

The makeup of the parent sex chromosomes	ZZ		ZW	
Makeup of the gametes (sperm and egg cells)	Z	Z	Z	W
Newly formed individual	ZZ	ZZ	ZW	ZW
Sex of the individual	Male	Male	Female	Female

If a homozygous rapid feathering male "kk" is mated to a hemizygous slow feathering female K- (- indicates atrophied chromosome), the feathering of progeny will be as follows:-

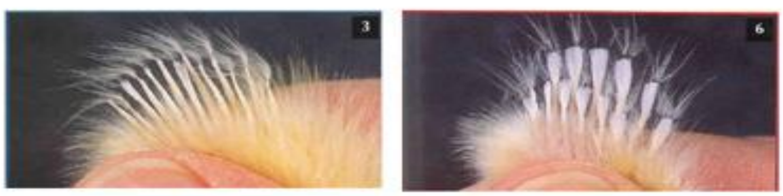
Parents	Z^kZ^k		Z^KW	
Gametes	Z^k	Z^k	Z^K	W
Progeny	Z^kZ^K	Z^kZ^K	Z^kW	Z^kW

Since these genes are carried on the sex chromosome, the sex and feathering are determined at the same time and illustrated in the following slide.

Sex	Male	Male	Female	Female
Feathering	Slow	Slow	Fast	Fast

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

Feather Sexing



Slow Feathering Male   Fast Feather Female

4 Catching and Transport

The manner in which birds are handled during catching and transported to processing will influence product quality to a very large extent. Birds are transported in plastic crates or modules. Some key guidelines need to be followed to ensure animal welfare and good product quality.

- The process needs to be well planned and co-ordinated to utilize trucks and catching crews as best as possible without waiting for the birds and birds having to remain in crates for long periods prior to slaughter
- Cull birds should have been removed through constant removal and humane disposal of such birds during the growing cycle
- Withdrawal periods of any drugs and coccidiostats must be respected and followed
- Feed should be withdrawn 6 to 8 hours prior to processing and this period includes the transport time. Do not prolong feed withdrawal
- Water should be available to the birds for as long as possible up to the point of catching. Split drinker lines will assist in this regard
- Remove equipment or winch it out of the way prior to commencement of catching
- Portable wire frames will assist in reducing herding and overcrowding and assist in keeping birds destined to be caught later in demarcated areas
- Birds are to be caught by the shank and feet (not by the thigh) and gently placed in crates. Serious downgrading will result from lack of care due to bruising, broken limbs and internal bleeding. When birds are handled poorly, meat quality is adversely affected
- Avoid trucks standing in direct sunlight and extreme wind and cold conditions. Adequate ventilation through the load is important
- When modified light programs are followed, the normal 23 hours light per day should by applied from at least 5 days prior to processing. This will eliminate any excessive activity during catching
- Lights are to be dimmed as low as possible without affecting the ability of the crew to see properly
- Note that the negative pressure in the building will be affected when doors are opened and certain areas in the building may no longer be adequately ventilated

5 Health and Hygiene

Modern broiler production requires strict control on disease prevention. The success of disease prevention rests very heavily on management procedures as well as bio-security measures, proper cleaning and disinfection of the premises between crops, proper disposal of mortality and adequate immunization of the birds.

Good management practices will not only contribute to the prevention of disease but when a disease break does occur, the effects will be less severely in well managed flocks.

This section will only provide a brief overview of the measures to be followed in disease prevention and further reference in veterinary books and manuals is needed for a full understanding of this very important topic of broiler management.

5.1 Cleaning and Preparation

Some specific and more common disorders and diseases are discussed from a management point of view. This section is not intended to provide a complete overview of the common diseases that may be encountered.

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. Although young chicks may carry some parental immunity, it will not be adequate to face severe challenges.

5.1.1 Litter Removal

Prior to removal of litter, all ventilation and electrical systems should be switched off. 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 remove all dust and litter from within the building. A good procedure of litter removal would consist of:-

- If litter is very dry, it will be advantageous to dampen down the dust by spraying water onto the litter and walls by low pressure or knapsack spray
- All equipment should be removed or winched to the ceiling
- When placed outside the building, this should be done on concrete areas on which the equipment can be properly cleaned and also the area cleaned after the process
- All fans, fan cowls, shutters, beams, etc. should be dusted and dust allowed to fall to the floor
- Litter is 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 close to the broiler site.

5.1.2 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. Once the inside of the building has been cleaned, all equipment removed outside the building is washed and moved back into 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.

All water and feed equipment should be thoroughly cleaned, disinfected and made ready for use during the next crop of chickens.

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 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 be repaired
- The bulk feed bin should be clean out with detergent
- The system is then re-assembled and disinfected

The external areas should also be kept cleaned. The areas where major activity such as loading of birds, parking of feed trucks, etc., should preferable by paved or concreted for proper cleaning. The areas between buildings should be free of vegetation, well drained and if grassed, such grass should be kept short. This will eliminate interference with ventilation and any problems with rodent infestation will be easily noticeable.

5.1.3 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 and surfaces over which the insects migrate should be covered before this occurs.

Should the infestation be high a second treatment may be required before final fumigation and disinfecting of the premises. Warming the building during this process 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.

5.1.4 Rodent Control

The control of rats and mice in poultry sheds is very important, because they can cause severe damage to electrical wires, plastic piping, wet pads and insulation material and they are 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.

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 intake. Mice do not need drinking water
- Poisoned grain wrapped in newspaper can be stuffed into any holes used by rodents
- Keep a lookout for any sign of rat holes and 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
- Sugar, vegetable oils and non-rancid animal fats increase the acceptance of cereal baits
- Keep water tanks completely closed.
- 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
- 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
- Side 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.

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.

It is essential that rat bait be kept properly locked and away from possible use of non-qualified persons.

5.1.5 Monitoring the Cleaning Program

The clean out program should be monitored by visual inspection as well as through evaluation of the total viable bacterial counts. The latter should be conducted through consultation with a reliable laboratory.

Insects and micro-organisms build up immunity to chemicals which are used to kill them and it may be necessary to alternate or stop using certain chemicals for a period of time. This should only be done under guidance of knowledgeable expertise.

This should also incorporate the monitoring for Salmonella.

5.2 Biosecurity

The health of poultry may be affected by specific avian pathogens and it is important to prevent their introduction to the premises, not only from a flock health and welfare point of view but also in the interest of the consumer as certain pathogens may not only affect product quality but could have direct consequences on human health as well (i.e. Salmonella).

Pathogens may be introduced onto the premises by means of Vertical Transmission or Horizontal Transmission.

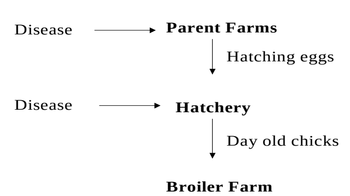
It is necessary that a bio-security program be developed for every circumstance. All staff, regular service crew and visitors should be aware of the measures and the prescribed procedures followed at all times.

The Disposal of mortality should be done in such a manner that the risk of spreading possible diseases which has caused the mortality, is reduced

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

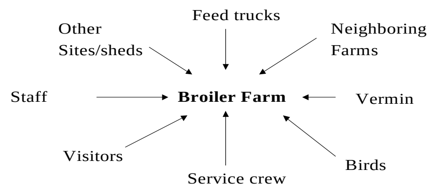
To prevent vertical transmission of diseases it is advisable that broiler chicks are sourced from a reputable hatchery and that the disease status of the chick is known.

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, if not by farm or site then at least by shed
- 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 form feed companies who practice Salmonella control monitoring
- Vermin must be controlled



Normal mortality should be removed from the poultry shed and disposed of on a daily basis and more often if mortality is above normal. Any cull birds (runts, cripple birds, etc.) should be killed in a humane manner and also disposed of. This is done by firmly holding the bird by both legs in one hand, placing the neck between the second and third finger with the back of the head against the palm of the second hand and with a firm but gentle jerk and pull with the head twisted back, dislocating the neck.

Although more expensive, the most satisfactory method of disposing of mortality is through incineration by gas, oil or solid fuel burners. The use of an open trench is not recommended as this will soon attract scavengers and act as source of disease and contamination.

Disposal mortality pits work satisfactory if they are well constructed. The dome should be fly proof and provided the pit remains dry, decomposing of the carcasses will readily occur if mortality is normal and the pit not overloaded. Additional chemicals are available to assist in the decomposing process.

Exceptional high and sudden mortality should be disposed of by immediate burial in deep trenches.

5.3 Immunization

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 which will actively protect the bird from subsequent natural field challenges. Although common diseases such as Newcastle, Infectious Bronchitis and Infectious Bursal Disease are routinely vaccinated, 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 nl. Live vaccines or Killed Vaccines each of which have specific use and advantages in broiler production.

Live vaccines are most commonly used in broiler production and they may be administered in via the drinking water or through spray vaccination.

Avoid vaccinating birds that are showing clinical signs of illness or stress.

5.3.1 Live Vaccines

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 broiler production include Infection Bronchitis (IB), Newcastle (NCD) and Infectious Bursal Disease (Gumboro). Normally the live vaccines contain only one antigen but combinations of IB and NCD are available.

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.

5.3.1.1 Administering Vaccine through Drinking Water

The water intake of the flock at the time of administration should therefore be known and if not, the guide in Table 6 may be used but care should be taken that this may not be accurate as local circumstances (temperature, flock health, etc.) will dictate actual consumption. The hourly rate of consumption is then calculated and the amount of water to which the vaccine is 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 trail 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. 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.

Live vaccines are best administered by using a dosing applicator.

Dye tablets 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.

5.3.1.2 Administering Vaccines through Spray Method

Vaccines may be administered by spray method using various types of applicators available in the market. Some key points 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.

- 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 trail and error using guides supplied by the manufacturer. The vaccine must be administered within the period of one hour.

5.3.2 Killed Vaccines

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 not commonly used in broiler production due to the vaccine having to be administered through injection which is time consuming and labour intensive. The reaction time is also slower, compared to live vaccines.

Their common use is in the chick production process where parents are vaccinated by these killed vaccines to enhance the passive immunity passed on to the chick from the parent (also referred to as parental immunity).

5.4 *Managing Disease Problems*

To a large extent, many of the common diseases may be prevented by good management practices and high hygiene and bio-security standards. A drop in water and feed intake is one of the first signs of a disease challenge and good records and monitoring thereof will provide for early warning.

If a problem is suspected, then immediate action is called for by seeking veterinary assistance. Early appropriate action and treatment will assist to minimize the adverse effects of the disease and possible development of secondary complications.

The three most common problems encountered include:

5.4.1 Respiratory Disorders

Respiratory diseases are commonly caused by viral and bacterial infections but the effect of such infections are largely exacerbated by poor management.

The symptoms of respiratory disease should be recognized as early as possible. By the time clinical signs are obvious (gasping for air) the birds are seriously ill and more than likely too late to be treated.

Early warning signs include:

- Birds become quite and less active
- A faint snicking or clicking may be heard
- Eyelids may show slight swelling and change in shape (from round to a more oval shape)

As the disease progresses the signs develop into:

- Rattling or coughing sound caused by mucus in the trachea
- Eyelids become swollen and watery
- Birds show signs of chill (puffing of feathers) become very quiet
- Breathing becomes more difficult with necks extended and beaks open

Early detection, immediate and appropriate action and prevention of the problem developing into secondary infection are key in the management of respiratory disorders.

Mismanagement of the environment will seriously affect the respiratory system and not only enhances the possibility of a challenge developing into a serious disease problem but will also cause severe complications, if a disease challenge does occur.

Key issues in managing respiratory disorders include:

- Over ventilation causes dry and dusty conditions which will overload the mucus and immune cells of the respiratory tract, causing a lack of local immunity
- Under ventilation will result in wet conditions short of oxygen and high in ammonia. Ammonia stops the ciliary action in the respiratory tract (movement of hair-like cells which moves mucus)

- Birds that are cold will be under stress and house temperature within the desired range is essential.
- Infections such as *Mycoplasma synovia* (MS) and *Mycoplasma Galisepticum* (MG) should be avoided as will complicate the problem through possible secondary infection. MS and MG free chicks should therefore be sourced.

Viral and bacterial infections, nutritional imbalances and deficiency as well as exceptional high growth rate may give rise to leg abnormalities.

5.4.2 Leg Abnormalities

Some leg abnormalities, especially in the beginning are difficult to distinguish from nervous disorders. Signs of leg abnormalities include:

- Birds are lethargic, weak and unwilling to move
- Birds are deformed and lack bilateral symmetry
- Birds are lame and paralyzed
- Birds have swollen hocks or feet

A low percentage (< 0.5%) of birds will always show some leg abnormality. These birds are to be removed as soon as they as seen and disposed of in a humane manner.

It is best to seek professional veterinary advice in dealing with severe leg abnormalities.

5.4.3 Ascites

Cause

Ascites is a condition in which an accumulation of non-inflammatory fluid in the hepatic, peritoneal and pericardial cavities occurs and will be seen at a low incidence (< 2%) in normal broiler flocks. Historically this was commonly referred to as "High Altitude Disease" as it is more prevalent when broilers are grown at altitude. Although breeders have incorporated resistance to ascites in breeding programs, it remains a fairly common disease problem, especially under poor management conditions.

Selection pressure on growth rate as well as improved diets has resulted in increased metabolic rate. This has lead to a high oxygen demand and coupled to the relatively poor lung capacity of broilers, it causes an increase in pulmonary blood pressure. This in turn causes enlargement of the right ventricle of the heart, leading to dilation, right heart failure, congestion and then ascites.

Any factor that increases the already high oxygen demand or reduces the availability of oxygen in the broiler shed will increase the incidence of this disorder. A variety of factors could therefore be involved in the incidence of this disorder.

Symptoms

The true symptoms of ascites will usually only be noticed once right ventricle failure occurs. Once ascites develops birds will stop growing and such birds will then be smaller than normal birds.

Affected birds will be depressed are reluctant to move and have ruffled feathers. Often the skin is reddened and it is fairly common to see distended abdomens and respiratory distress. Mortality may also occur prior to ascites settling in. Such birds die on their back as a result of acute death (heart failure) and on post mortem these birds will be found to have enlarge right heart ventricle.

On post mortem, birds will enlarged and dilation of the right ventricle and fluid in the heart sac, with or without ascites in the abdomen. The liver, spleen and kidneys will be swollen with congestion in the lungs.

Aggravating Conditions

Altitude - More problems will be noticed when broilers are grown at altitude due to lower atmospheric pressure and therefore lower oxygen pressure resulting in lower uptake of oxygen by the lungs

Temperature - Low environmental temperature as well as large diurnal fluctuation in temperature increases the demand for oxygen. Broilers are therefore susceptible in the post brooding period and especially in winter when there is planned reduction of the environmental temperature. Houses in which the temperature inside the building cannot be maintained during winter will be more problematic.

Ventilation - Inadequate ventilation will reduce the oxygen content of air and increase the levels of gases that may damage the lungs (e.g. ammonia). Over ventilation in dry climate conditions may also create very dry and dusty conditions, which also may damage the lungs and lining of the respiratory tract. Correct amount of ventilation at the correct temperature is essential in maintaining conditions that will maximize oxygen supply and uptake by the birds.

Aggravating Conditions (Cont.)

Respiratory Infection - Impaired lung efficiency as a result of diseases that affect the respiratory tract will reduce oxygen uptake. Even small vaccine reactions may trigger the development of this disorder, especially when environmental conditions are not optimum.

Growth Rate and Nutrition - High growth rates increase the demand for oxygen. For this reason males are more susceptible, the incidence is higher with pelleted feed compared to mash feed, very dense diets increases the demand for oxygen (increased metabolic rate). A balance between optimum growth and mortality must therefore be found.

Other Factors

- Chicks that have been poorly hatched (lack of ventilation during and after incubation) show early signs of this disorder.
- Mycotoxins in the feed have also been shown to increase the incidence of ascites. These toxins are contaminants of mouldy feed (from feed bins) or feed manufactured from contaminated ingredients.

5.5 Appearance of Healthy versus Sick Birds

	Healthy Bird	Sick Bird
Stance	Erect, tail held up	Tail and wings droop, head held close to the body, twisted back or between legs
Head	Clean pinkish red comb and wattles, bright and alert eyes and clean nostrils. Eyes more round	Discoloured shrunken comb and wattles, eyes dull and watery, nostrils caked, face swollen, eyelids closed and swollen. Eyes more oval shaped
Legs and feet	Clean waxy scales, smooth joints cool to the touch	Dehydrated with prominent tendons, enlarged joints warm to the touch and feet swollen and cracked
Feathers	Smooth and neat	Ruffled and stained on the vent
Thirst and appetite	Eat and drink often	Loss of appetite and birds often more thirsty in beginning
Droppings	Grey/brown with white caps, definite form. Ceacal droppings may be frothy	Discoloured, watery or sticky, excess odour and could contain blood
Breathing	Silent, beak closed under normal temperature	Stressful, coughing, snickering and obvious panting movements