Broiler Management Guide

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INTRODUCTION

The Cobb commitment to genetic improvement continues to increase the performance potential in all areas of broiler and broiler breeder production. However, to attain both genetic potential and consistent flock production, it is important that the flock manager has a good management program in place. The worldwide success of Cobb has provided considerable experience of the breeds in a wide range of situations such as hot and cold climates, controlled environment and open housing. This Cobb Broiler Management Guide is designed to assist you in building your management program.

Management must not only meet the basic needs of the stock but must also be finely tuned to benefit fully from the breed's potential. Some of the guidelines may need to be adapted locally according to your own experience with assistance from our technical team.

The Cobb Broiler Management Guide highlights critical factors that are most likely to influence flock performance and is part of our technical information service, which includes the Cobb Hatchery Guide, Technical Bulletins and a full range of performance charts. Our recommendations are based on current scientific knowledge and practical experience around the world. You should be aware of local legislation, which may influence the management practice that you choose to adopt.

The Cobb Broiler Management Guide is intended as a reference and supplement to your own flock management skills so that you can apply your knowledge and judgment to obtain consistently good results with the Cobb family of products.

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1. HOUSE DESIGN

Conventional & Closed Environment

There are many things to consider when selecting the most suitable type of broiler housing and related equipment. Though economic constraints are generally foremost, factors such as equipment availability, after sales service and life of the products are also critical. Housing should be cost effective, durable and provide a controllable environment.

When planning the construction of a broiler house, one should first select a well-drained site that has plenty of natural air movement. The house should be oriented on an east-west axis to reduce the effect of direct sunlight on the sidewalls during the hottest part of the day. The main objective is to reduce the temperature fluctuation during any 24-hour period. Good temperature control always enhances feed conversion and growth rate.

The following are the four key components of any new broiler house:

- Roofing material should have a reflective surface on the outside to help reduce the conduction of solar heat and should be well insulated.
- Heating systems should have ample heating capacity in accordance with the climate.
- Ventilation systems should be designed to provide ample oxygen and to maintain optimum temperature and relative humidity conditions for the birds.
- Lighting should be oriented to provide an even distribution of light at the floor level.

1.1 STOCKING DENSITY

Correct stocking density is essential to the success of a broiler production system by ensuring adequate room for optimal performance. In addition to the performance and profit considerations, correct stocking density also has important welfare implications. To accurately assess stocking density, factors such as climate, housing types, ventilation systems, processing weight and welfare regulations must be taken into account. Incorrect stocking density can lead to leg problems, scratching, bruising and mortality. Furthermore, litter integrity will be compromised.

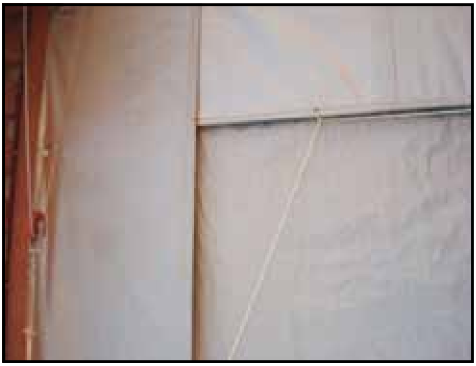
Thinning a portion of the flock is one approach to maintaining optimum bird density. In some countries, a higher number of birds are placed in a house and reared to two different weight targets. At the lower weight target, 20-50% of the birds are removed to satisfy sales in this market segment. The remaining birds then have more space and are reared to a heavier weight.

Many different stocking densities are employed around the world. In warmer climates a stocking density of 30 kg/m² is closer to ideal. General recommendations are:

House Type	Ventilation Type	Equipment	MAXIMUM Stocking Density
Open Sided	Natural	Stir Fans	30 kg/m² (6.2 lb/ft.²)
Open Sided	Positive Pressure	Side wall fans @ 60º	35 kg/m² (7.2 lb/ft.²)
Solid Wall	Cross Ventilation	European Setup	35 kg/m² (7.2 lb/ft.²)
Solid Wall	Tunnel Ventilation	Foggers	39 kg/m² (8.0 lb/ft.²)
Solid Wall	Tunnel Ventilation	Evaporative Cooling	42 kg/m² (8.6 lb/ft.²)

1.2 KEY DESIGN REQUIREMENTS FOR CURTAIN INSTALLATION

- The top of the curtain must overlap a solid surface to prevent leaks; an overlap of at least 15 cm (6 in.).
- A 25 cm (10 in.) mini curtain installed on the outside of the house at eave height will further prevent leaks over the top of the curtain.
- The curtains should fit into an envelope which is a 25 cm (10 in.) mini curtain that seals the curtain vertically on both ends.
- Curtains should be triple hemmed.
- Curtains need to be sealed at the base to prevent air leaks at floor level.
- All holes and tears in sidewall and/or inlet curtains must be repaired.
- Curtains work most efficiently if operating automatically using both temperature and wind speed as criteria for opening and closing.
- The optimum dwarf wall height is 0.50 m (1.6 ft.).
- The roof overhang should be 1.25 m (4.1 ft.).



1.3 INSULATION

Key to maximizing bird performance is the provision of a consistent house environment. Large fluctuations in house temperature will cause stress on the chick and affect feed consumption. Furthermore, these fluctuations will result in additional energy expenditure to maintain body temperature. This will help to conserve heating costs, reduce solar energy penetration and prevent condensation.

The most important insulation requirements are in the roof. A well insulated roof will reduce solar heat penetrating the house on warm days, thus decreasing the heat load on the birds. In cold weather a well insulated roof will reduce heat loss and energy consumption needed to maintain the correct environment for the chick during the brooding phase, the most important time in the development of the chick.

The roof should be insulated to a minimum R-value of 20-25 (climate dependant).

The insulating ability of materials is measured in R-values. The higher the R value the greater the insulating properties of the material. When selecting any insulation material, cost per R-value rather than cost per thickness of material is the most important consideration. Below are some insulating materials and their respective R-values.

Insulating materials and values:

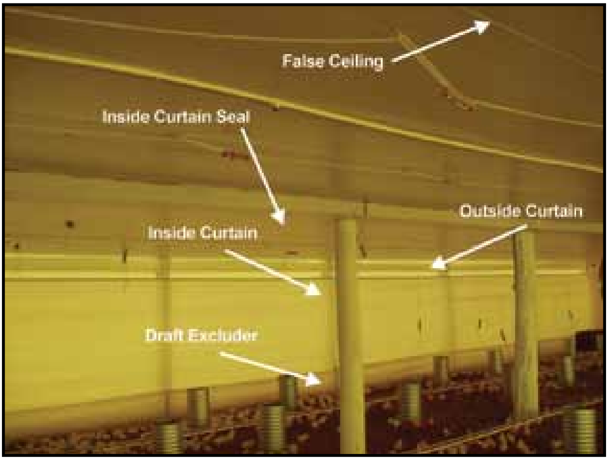
Material	R - Value per 2.5 cm (1”)
Polystyrene bead board	Average-R-3 per 2.5 cm
Blown in or fill: cellulose or glass	Average-R-3.2 per 2.5 cm
Batts or Blankets: fiberglass	Average-R-3.2 per 2.5 cm
Polystyrene: plain extruded	Average-R-5 per 2.5 cm
Polyurethane foam: “unfaced”	Average-R-6 per 2.5 cm

U value - *coefficient of heat transmission*, a measure of the rate of non-solar heat loss or gain through a material. U-values gauge how well a material allows heat to pass through. U-value ratings generally fall between 0.20 and 1.20. The lower the U-value, the greater a product’s resistance to heat flow and the better its insulating value. The inverse of the U-value is the R-value.

The required roof R-value is 20 (SI metric 3.5) & U-value 0.05. This will help to conserve heating costs, reduce solar energy penetration and prevent condensation.

1.4 BROODING CHAMBER

In poorly insulated buildings, one can reduce temperature fluctuations by building a mini tent inside the house. The mini tent is comprised of a false ceiling that runs from eave to eave. This false ceiling will greatly reduce heat loss and make temperature control easier. A second internal curtain one meter from the outside curtain needs to be installed. The internal curtain will completely seal from the floor to the false ceiling at the eaves. This curtain must open from the top and never from the bottom. The slightest air movement at floor level will cause chilling on the chicks. This second curtain can be used for early ventilation.



1.5 EQUIPMENT

1.5.1 DRINKER SYSTEMS

Providing clean, cool water with adequate flow rate is fundamental to good poultry production. Without adequate water intake, feed consumption will decline and bird performance will be compromised. Both closed and open watering systems are commonly used.

BELL OR CUP DRINKERS (OPEN SYSTEMS)

While there is a cost advantage of installing an open drinker system, problems associated with litter quality, condemnations and water hygiene are more prevalent. Water purity with open systems is difficult to maintain as birds will introduce contaminants into the reservoirs resulting in the need for daily cleaning. This is not only labor intensive but also wastes water.

Litter conditions are an excellent means of accessing the effectiveness of water pressure settings. Damp litter under the water source indicates drinkers are set too low, the pressure is too high or there is inadequate ballast in the drinker. If litter under the drinkers is excessively dry, it may indicate water pressure is too low.

Installation recommendations:

- Bell drinkers should provide at least 0.6 cm (0.24 in.) per bird of drinking space.
- All bell drinkers should have a ballast to reduce spillage.

Management recommendations:

- Bell and cup drinkers should be suspended to ensure that the level of the lip of the drinker is equal to the height of the birds' back when standing normally.
- Height should be adjusted as the birds grow in order to minimize contamination.
- Water should be 0.5 cm (0.20 in.) from the lip of the drinker at day old and gradually decreased to a depth of 1.25 cm (0.50 in.) after seven days of age, about the depth of a thumbnail.

NIPPLE SYSTEMS (CLOSED SYSTEMS)

There are two types of nipple drinkers commonly used:

- ***High flow nipple drinkers*** operate at 80-90 ml/min (2.7 to 3 fl. oz/min). They provide a bead of water at the end of the nipple and have a cup to catch any excess water that may leak from the nipple. Generally 12 birds per nipple with high flow rate systems are recommended.
- ***Low flow rate nipple drinkers*** operate at a flow rate of 50-60 ml/min (1.7 to 2 fl. oz/min). They typically do not have cups, and pressure is adjusted to maintain water flow to meet the broiler's requirements. Generally 10 birds per nipple with low flow rate systems are recommended.

Installation recommendations:

- Nipple systems need to be pressurized either by installing a header tank or pump system.
- In houses with a slope in the floor, slope regulators should be installed per manufacturer's recommendations to manage the water pressure in all parts of the house. Other options to achieve this include: split lines, pressure regulators or slope neutralizers. In houses with sloped floors, pressure regulators should be installed on the high side of the house.
- Birds should not have to travel more than 3 m (10 ft.) to find water. Nipples should be placed at a maximum of 35 cm (14 in.) centers.

Management recommendations:

- Nipple drinking systems are less likely to become contaminated than open systems.
- Nipple drinkers must be adjusted to suit chick height and water pressure. As a general rule birds should always have to slightly reach up and never stoop down to reach the trigger pin - feet must be flat on the floor at all times.
- For systems with stand pipes, pressure adjustments should be made in 5 cm (2 in.) increments - as per manufacturers recommendations. Systems with drip trays should be managed that birds never drink from the drip trays. If water is present in drip trays the pressure is too high in the system.
- For optimal broiler performance, it is recommended to use a closed drinker system. Water contamination in a closed nipple drinker system is not as likely as with open drinker systems. Wasting water is also less of a problem. In addition, closed systems offer the advantage of not requiring the daily cleaning necessary with open drinking systems. However, it is essential to regularly monitor and test flow rates as more than a visual assessment is required to determine whether all nipples are operational.

1.5.2 WATER METERS

Monitoring water consumption through the use of water meters is an excellent means of gauging feed consumption, as the two are highly correlated. Water meters should be sized the same as the incoming water supply line to ensure adequate flow rate. Water consumption should be evaluated at the same time each day to best determine general performance trends and bird well-being.

Note: install a water meter bypass, to be utilized during flushing – water used during regular flushing procedures should not be included in the daily water intake reading.

Any substantial change in water usage should be investigated as this may indicate a water leak, health challenge or feed issue. A drop in water consumption is often the first indicator of a flock problem.

Water consumption should equal approximately 1.6-2 times that of feed by mass, but will vary depending on environmental temperature, feed quality and bird health.

- Water consumption increases by 6% for every increase in 1 degree in temperature between 20-32 °C.
- Water consumption increases by 5% for every increase in 1 degree in temperature between 32-38 °C.
- Feed consumption decreases by 1.23% for every increase in 1 degree in temperature above 20 °C.

Relation between ambient temperature and water feed ratio

Temperature ºC / ºF	Ratio water and feed
4 °C / 39 °F	1.7:1
20 °C / 68 °F	2:1
26 °C / 79 °F	2.5:1
37 °C / 99 °F	5:1

Singleton (2004)

1.5.3 WATER STORAGE TANKS

Adequate water storage should be provided on the farm in the event that the main system fails. A farm supply of water equal to the maximum 48 hour demand is ideal. The storage capacity is based on the number of birds plus the volume required for the evaporative cooling system.

The following table is an example of the maximum cooling pad water requirement of a modern tunnel ventilated broiler house operating at an airspeed of 3m/s (600 fpm)

House Width, Air Speed, Tunnel Fan Capacity and 6 ft. Pad Water Requirement:

House Width	Air Speed	Tunnel Fan Capacity	No Fans (790m³/min or 28,000 cfm)	Pad Requirement
12m (40ft)	3m/s (600 fpm)	6456m³/min (228,000 cfm)	8	45 l/min
15m (50ft)	3m/s (600 fpm)	8093m³/min (285,800 cfm)	10	53 l/min
18m (60ft)	3m/s (600 fpm)	9684m³/min (342,000 cfm)	12	64 l/min
20m (66ft)	3m/s (600 fpm)	10653m³/min (376,200 cfm)	13	72 l/min

If the source of water is a well or holding tank, the supply pump capacity should match the birds' maximum water consumption and also the maximum needs of the fogging and/or evaporative cooling systems.

Separate water supplies for both the birds and cooling systems should be installed for each house. The following is a table indicating estimated flow rates for different pipe sizes:

Flow rate (l/min)	Pipe Size (mm and in)
20 l/min	20 mm or 0.75"
38 l/min	25 mm or 1"
76 l/min	40 mm or 1.5"
150 l/min	50 mm or 2"
230 l/min	65 mm or 2.5"
300 l/min	75 mm or 3"

Storage tanks should be purged between flocks. In hot climates tanks, should be shaded because elevated water temperatures will decrease consumption. The ideal water temperature to maintain adequate water consumption is between 10 - 14 °C (50 - 57 °F).

1.5.4 FEEDING SYSTEMS

Regardless of which type of feeding system is used, feeding space is absolutely critical. If feeder space is insufficient, growth rates will be reduced and uniformity severely compromised. Feed distribution and the proximity of the feeder to the birds are key to achieving target feed consumption rates. All feeder systems should be calibrated to allow for sufficient feed volume with minimal waste.

A. Automatic Feeder Pans:

- 50-70 birds per 33 cm (12 in.) diameter pan are recommended.
- Require overflow (flood) setting for chick start.

Pan feeders are generally recommended as they allow for unrestricted bird movement throughout the house, have a lower incidence of feed spillage and improved feed conversion.

Feeder pans should be primed on each entry to the house to keep the system full.

If birds are “tipping” the pans to reach the feed, then the pans are set too high.

House Width	Number of Feed Lines
Up to 12.8 m (42 ft.)	2 lines
13 m (43 ft.) to 15 m (50 ft.)	3 lines
16 m (51 ft.) to 20 m (65 ft.)	4 lines
21 m (70 ft.) to 25 m (85 ft.)	5 lines

B. Automated Chain Feeders:

- Should allow for a minimum of 2.5 cm (1 in.) feeder space per bird - when determining feeder space, both sides of the chain must be included.
- Lip of feeder track must be level with the birds' back.
- Maintenance of feed track, corners and chain tension is essential.
- Feed depth is controlled by feed slides in the hoppers and should be closely monitored to prevent feed wastage.

C. Feed Storage Bins:

- Feed storage bins should have a holding capacity equal to 5 days of feed consumption.
- To reduce the risk of mold and bacterial growth, it is essential that bins are watertight.
- It is recommended that two feed bins be used for each house. This allows for a rapid change in feed if it becomes necessary to medicate or meet feed withdrawal requirements.
- Bulk feed bins should be cleaned between flocks.

1.5.5 HEATING SYSTEMS

The key to maximizing bird performance is providing a consistent housing environment - a consistent ambient & floor temperature for young birds. The heating capacity requirement depends on ambient temperature, roof insulation and the degree of house sealing. **Recommendation:** Roof insulation R-value 20 (well insulated roof), with the heating capacity requirement of 0.05 kwh/m^3 of house volume for temperate climates, and 0.10 kwh/m^3 of house volume in climates where winter time temperatures are commonly are below zero Celsius. The following heating systems are available:

- Forced air heaters: These heaters need to be placed where the air movement is slow enough to allow optimum heating of the air, normally in the middle of the house. These heaters should at be placed a height of 1.4-1.5 metres from the floor; a height which will not cause drafts on the chicks. Forced air heaters should never be placed near the air inlet because is impossible for forced air heaters to heat air that is moving too fast. Heaters placed at the inlets will lead to an increase in heating energy usage and cost.
- Radiant / Spot brooders: Either traditional pancake brooders or radiant brooder systems are used to heat the litter within the house. These systems allow the chicks to find their comfort zone. Water and feed should be in close proximity.
- Under Floor Heating: This system operates with hot water circulating through pipes in a concrete floor. The heat exchange within the floor warms the litter and the brooding area.

Recommendation: Radiant brooders to be used in conjunction with space heaters. Radiant brooders are used as a primary heat source during brooding while space heaters provide supplemental heat in cold weather. As the flock matures, birds develop the ability to regulate their internal body temperature. At approximately 14 days of age, forced air heaters can become the primary heat source. Generally, radiant type heaters should be used for poorly insulated houses as the main source of heat while forced air heating can be used for well insulated solid wall houses.

1.5.6 VENTILATION SYSTEMS

Importance of Air Quality:
The main purpose of minimum ventilation is to provide good air quality. It is important that the birds always have adequate oxygen, optimum relative humidity and minimum amounts of carbon dioxide (CO_2), carbon monoxide (CO), ammonia (NH_3) and dust - see air quality guidelines.

Inadequate minimum ventilation and the resulting poor air quality in the poultry house can cause increased levels of NH_3, CO_2, moisture levels and an increase in production related syndromes such as ascites.

Always evaluate NH_3 levels at bird height. The negative effects of NH_3 include: foot pad burns, eye burns, breast blisters/skin irritations, decreased weights, poor uniformity, disease susceptibility and blindness.

Air Quality Guidelines	
Oxygen %	> 19.6%
Carbon Dioxide	< 0.3% / 3,000 ppm
Carbon Monoxide	< 10 ppm
Ammonia	< 10 ppm
Relative Humidity	45-65%
Inspirable Dust	< 3.4 mg/m^3

For a detailed discussion of ventilation, please refer to Item 6, beginning on page 26.

2. HOUSE PREPARATION — PRE-PLACEMENT

Housing Configuration:
There are several approaches to setting up a house for brooding. Housing design, environmental conditions and resource availability will determine the housing set up.

2.1 WHOLE HOUSE

Whole house brooding is generally limited to solid sidewall housing or houses located in mild climates. The most important aspect to whole house brooding is to produce an environment without temperature fluctuations.

2.2 PARTIAL HOUSE

Partial house brooding is commonly practiced in an attempt to reduce heating costs. By reducing the amount of space dedicated to brooding, one can conserve the amount of heat required and reduce energy costs. In addition, correct temperatures are more easily maintained in a small area.

The aim of partial house brooding should be to use as large a brooding space as heating capacity and house insulation will allow in order to maintain desired house temperature depending on local weather conditions. Increasing the brooding area depends on heating capacity, house insulation and outside weather conditions. The goal is to increase the brooding area as soon as possible as long as the desired house temperature is being achieved. Prior to opening, the unused brooding needs to be heated and ventilated to the desired bird requirement at least 24 hours before releasing birds into the new area. Below is an example of partial house brooding:

Up to 7 days	-	1/2 of the house
8 to 10 days	-	1/2 to 3/4 of the house
11 to 14 days	-	3/4 of the whole house

Several strategies for house division are employed worldwide. Floor to ceiling curtains are most commonly used to divide a house. A solid 20 cm (8 in.) barrier should be placed on the floor in front of the curtain ensuring that no drafts disturb the chicks. Partial house brooding can be managed similarly to whole house brooding with the use of a centrally located heat source and attraction lights.

The placement density will depend on the brooding area being utilized. Stocking should not exceed more than 50 - 60 birds/m² during the winter & 40 - 50 birds/m² during the summer. Ensure adequate drinking space especially during summer placements - do not exceed 20 - 25 birds per nipple.

2.3 ATTRACTION LIGHTS

With radiant type heaters, attraction lights running centrally along the length of the brooding area are placed above the heat source to attract chicks to feed and water. Attraction lights are best used during the first five days following placement. At day five, background lights should be gradually increased, reaching normal whole house lighting by day ten. These lights can also be hung over demand pans to keep the feeding system primed for the first fourteen days of age.

2.4 LITTER MANAGEMENT

Seldom given sufficient emphasis, litter management is another crucial aspect of environmental management. Correct litter management is fundamental to bird health, performance and final carcass quality which subsequently impacts the profit of both growers and integrators.

The litter is the main residue of the broiler house. Re-use of litter is practiced in a number of countries with a degree of success. Health and economic aspects beyond the environmental legislation must be taken into account before deciding to re-use the litter.

The following are some key points to consider when re-using the litter:

- Down time between flocks should be at least 12 days to maintain good litter quality.
- All wet caked litter to be removed during down time
- In the case of a disease challenge, it is never recommended to re-use the litter.
- The availability and cost to replace old litter.

Generally, the best performance is achieved when litter is replaced annually, or if possible, after four flocks.

2.4.1 IMPORTANT FUNCTIONS OF LITTER

Important functions of litter include the ability:

- To absorb moisture.
- To dilute excreta, thus minimizing bird to manure contact.
- To provide an insulation from cold floor temperatures.

Though several alternatives may be available for litter material, certain criteria should apply. Litter must be absorbent, lightweight, inexpensive and non-toxic. Litter characteristics should also lend to post production applications whether for use as compost, fertilizer or fuel. The litter proprieties also should have medium particle size, good absorption capacity without any cakes, release easily to the air the humidity absorbed, have damping capacity even under high density, low cost and high availability.

2.4.2 LITTER ALTERNATIVES

- Pine Shavings - excellent absorptive qualities.
- Hardwood Shavings - may contain tannins which cause toxicity concerns and splinters that may cause crop damage.
- Sawdust - often high in moisture, prone to mold growth and chicks may consume it, which may cause aspergillosis.
- Chopped straw - wheat straw is preferred to barley straw for absorptive qualities. Coarse chopped straw has a tendency to cake in the first few weeks.

- Paper - difficult to manage when wet, may have a slight tendency to cake and glossy paper does not work well.
- Rice Hulls - an inexpensive option in some areas, rice hulls are a good litter alternative.
- Peanut Hulls - tend to cake and crust but are manageable.
- Cane Pummage - inexpensive solution in certain areas.

2.4.3 LITTER EVALUATION

A practical way to evaluate litter moisture is to pick up a handful and gently squeeze it. The litter should slightly adhere to the hand and break down when dropped to the floor. If moisture is in excess it will stay compacted even when dropped. If litter is too dry it will not adhere to your hand when squeezed. Excessive litter moisture (>35%) may cause welfare and/or health challenges. An increased incidence of breast blisters, skin burns, condemnations and downgrades may result. Litter with high moisture content may also contribute to elevated ammonia levels.

If litter becomes wet beneath drinkers, drinker water pressure should be evaluated and prompt action taken. After the cause has been identified and addressed, fresh litter or dry litter from within the house must be applied to the problem areas. Taking this action will encourage birds to utilize this area of the house again.

2.4.4 MINIMUM LITTER REQUIREMENTS

Litter Type	Minimum Depth OR Volume
Wood shavings	2.5 cm (1 in.)
Dry sawdust	2.5 cm (1 in.)
Chopped straw	1 kg/m^2 (0.2 $lb/ft.^2$)
Rice hulls	5 cm (2 in.)
Sunflower Husks	5 cm (2 in.)

2.5 PRE-PLACEMENT CHECKLIST

The key to successful broiler rearing starts with having a systematic and efficient management program in place. This program must start well before the chicks arrive on-site. Pre-placement house preparation as part of a management program provides a basis for an efficient and profitable flock of broilers. The following checks need to be made:

I. Equipment Check:
After confirming that the equipment capabilities meet the number of chicks to be placed, install the necessary brooding equipment and check that all equipment is functional. Ensure that all water, feed, heat and ventilation systems are properly adjusted.

II. Heater Checks:
Verify that all heaters are installed at the recommended height and are operating at maximum output. Heaters should be checked and serviced an adequate time BEFORE pre-heating commences.

III. Thermostats or Probes Check:

- Placed at bird height and in the center of the brooding area.
- Minimum and maximum thermometers should be placed adjacent to thermostat.
- Temperature ranges should be recorded daily and not deviate by more than 2 °C (4 °F) over a 24 hour period.
- These should be calibrated at least annually or sooner if doubt exists about accuracy.

IV. Floor temperature Check:

- Houses should be preheated so that both the floor and ambient temperatures and humidity are stabilized 24 hours before placement.
- To achieve the above targets, pre-heating needs to commence at least 48 hours before chick placement.
- Pre-heating time is dependent on climate conditions, house insulation and heating capacity and will vary from farm to farm.
- **Chicks do not have the ability to regulate body temperature for the first 5 days and thermo regulation is not fully developed until 14 days of age.** The chick is highly dependent upon the manager to provide the correct litter temperature. If the litter and air temperatures are too cold, internal body temperature will decrease, leading to increased huddling, reduced feed and water intake, stunted growth and susceptibility to disease.
- At placement, floor temperatures should be at least 32 °C (90 °F) [30-50% RH] with forced air heating. If radiant heaters / brooder stoves are used, floor temperatures should be 40.5 °C (105 °F) under the heat source.

Litter temperature should be recorded before each placement. This will help to evaluate the effectiveness of pre-heating.

V. Minimum Ventilation Check:

- Minimum ventilation should be activated as soon as the preheating begins to remove waste gasses and any excess moisture.
- Seal air leaks to eliminate drafts on chicks.

VI. Drinker Check:

- 14-16 drinkers/1,000 chicks (includes supplemental) should be provided within the brooding area of which 8-10 can be bell type drinkers.
- All drinkers should be flushed to remove any residual sanitizer.
- Adjust pressure to produce a droplet of water visible on each nipple without dripping.
- Check for water leaks and air locks.
- Ensure that nipple drinkers are at the chicks' eye level.
- Water must be clean and fresh.
- Supplemental drinkers should be placed in such a way that the chicks will make the association between supplemental drinkers and the main system.

VII. Feeder Check:

- Remove all water remaining from cleanout prior to filling.
- Supplemental feeders should be provided for the first 7-10 days in the form of paper, trays or lids.
- Trays should be provided at a rate of one per 50 chicks.
- Supplemental feeders should be placed between the main feed and drinker lines and adjacent to the brooders.
- **It is of utmost importance that the supplementary feeding system does not run empty as this will place great stress on the chick and reduce yolk sac absorption.**
- **The base of the supplementary feeders should never be exposed - keep full at all times!**
- Supplemental feeders should be refreshed three times daily until all the chicks are able to gain access to the main feeding system. This generally occurs at the end of the first week.
- Feed should be provided as a good quality crumble.
- Do not place feed or water directly under the heat source as this may reduce feed and water intake.
- The automatic system should be placed on the floor to make access easier for the chick. Where possible, flood automatic feeding systems with feed.
- If using paper, the feed area should be a minimum of 50% of the brooding area. 50-65 grams of feed per chick on the paper is recommended. The paper should be placed near the automatic drinking system so the chick can have easy access to both feed and water.

3. CHICK PLACEMENT

3.1 KEY MANAGEMENT REQUIREMENTS

- Place chicks from similar age and flock source in a single house; maximum 5 weeks difference if you need to mix donor flocks is recommended).
- Placement per farm should ensure an “all in-all out” regime.
- Delays in placement can contribute to the dehydration of chicks, resulting in higher chick mortality and reduced growth rate.
- Transportation must provide ideal conditions for the chicks and the delivery time should be as short as possible.
- Lower the light intensity during chick placement to reduce stress.
- Chicks must be carefully placed and evenly distributed near feed and water throughout the brooding area. When using supplemental feed on paper, place chicks on the paper.
- Weigh 5% of the boxes to determine day old chick weight.
- Lights should be brought to full intensity within the brooding area once all chicks have been placed.
- Following a 1-2 hour acclimation period, check all systems and make adjustments if necessary.
- Monitor the distribution of the chicks closely during the first few days. This can be used as an indicator for any problems in feeder, drinker, ventilation or heating systems.

3.2 CHICK QUALITY

Hatcheries can have a tremendous impact on the success of broiler rearing. The hatch process from egg to farm can be a stressful. Efforts to minimize stress are fundamental in maintaining good chick quality.

Characteristics of a good quality chick:

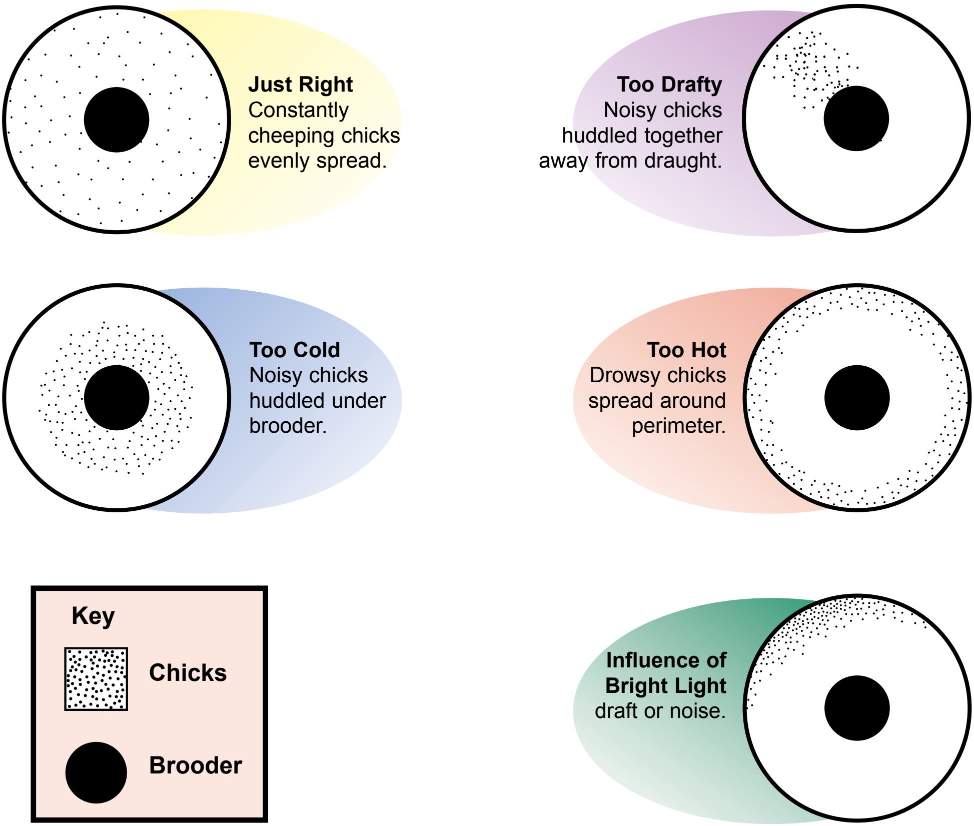
- Well-dried, long-fluffed down.
- Bright round active eyes.
- Look active and alert.
- Have completely healed navels.
- Legs should be bright and waxy to the touch.
- Free of red hocks.
- Chicks should be free from deformities (i.e. crooked legs, twisted necks and cross beaks).

3.3 BROODING MANAGEMENT

The importance of the brooding period cannot be over emphasized. The first 14 days of a chick's life sets the precedent for good performance. Extra effort during the brooding phase will be rewarded in the final flock performance.

Check chicks 2 hours after placement. Ensure they are comfortable. See the Proper Brooding Illustration:

Proper Brooding



3.4 INTERNAL CHICK TEMPERATURE

1. Chick internal temperature can be measured using a child ear thermometer.
2. Hatched chick internal temperature should be 40 - 41 ºC (104 - 106 ºF).
3. Chick internal temperature increases over the first five days to 41 - 42 ºC (106 - 108 ºF).
4. Chick internal temperature above 41 ºC (106 ºF) will lead to panting.
5. Chick internal temperature below 40 ºC (104 ºF) indicates that the chick is too cold.
6. A comfortable chick will breathe through its nostrils and loss 1-2 g of moisture in the first 24 hours.
7. The yolk also contains 1-2 g of moisture so the chick will lose weight but not become dehydrated.
8. If chicks start panting they can lose 5-10 g of moisture in the first 24 hours and then dehydration will occur.
9. Higher relative humidity will reduce moisture loss but also impair heat loss, so correct temperature is vital.
10. Chicks from smaller eggs (younger breeder flocks) require higher brooding temperatures because they produce less heat.
11. The yolk contains 2/3 fat and 1/3 protein-fat for energy and the protein for growth.
12. The yolk content should be less than 10% of the total chick weight.
13. If early feed consumption doesn't take place the chick will use both fat and protein in the yolk for energy resulting in adequate protein levels for growth.

3.5 BROODING VENTILATION

In addition to the correct temperature, ventilation needs to be considered. Ventilation distributes heat throughout the house and maintains good air quality in the brooding area. As chicks are more susceptible to air quality issues than are older birds, ammonia levels that produce a limited effect on a 7-week-old flock can reduce body weight gains of 7-day-old chicks by 20%. Ammonia levels should be kept below 10 ppm at all times.

Young birds are also very susceptible to drafts. Air speeds as slow as 0.5 m/s (100 ft./min) can cause a significant wind-chill effect on day old birds. If circulation fans are in use, they should be directed towards the ceiling to minimize downward drafts.

Maximum air speed across the bird based on age:

Age of Birds	Meters per Second	Feet per Minute
0-14 days	0.3	60
15-21 days	0.5	100
22-28 days	0.875	175
28 days+	1.75 - 3.0	350 - 600

Up to 14 days of age, minimum ventilation practices should be employed to circumvent inadvertent chilling of the birds. Do not use tunnel ventilation as minimum ventilation.

4. POST PLACEMENT OF CHICKS

4.1 POST PLACEMENT CHECKLIST

Ensure that both the feeders and drinkers are in adequate supply relative to the stocking density and are appropriately placed. Feeders and drinkers should be placed in close proximity to each other and within the “thermal comfort zone.”

I. Mini Drinker Check (Supplemental):

- Should be provided at a rate of 6/1,000 chicks.
- Should never be allowed to dry out.
- Must be cleaned and refilled as necessary.
- Maintain maximum water levels until chicks are large enough to create spillage.
- Should be removed approximately 48 hours after placement.
- Should be placed slightly higher than litter to maintain water quality yet not so high that access is impeded.

II. Bell Drinker Check:

- Height should be maintained such that the lip is at the level of the birds’ back.
- Frequent assessment and adjustment is essential.
- Must be cleaned **daily** to prevent buildup of contaminants. If necessary, in hot climates, flush the water system at least twice daily to maintain a good water temperature.
- Water should be 0.5 cm (0.20 in.) from the lip of the drinker at day of age and reduced gradually after seven days to a depth of 1.25 cm (0.5 in.) or thumbnail depth.
- All bell drinkers should be ballasted to reduce spillage.

III. Nipple Drinker Check:

- Height should be at chicks’ eye level for the first 2-3 hours of age and then maintained slightly above chicks’ head.
- Pressure should be such that there is a droplet of water suspended from the nipple but no leakage.
- The birds’ feet should always be flat on the litter and a bird should never have to stand on its toes to drink.
- Flush the lines as needed.

IV. Feeder Check:

- Feed should be provided in crumb form and placed on trays, lids or paper.
- Feeders should be raised incrementally throughout the growing period so that the lip of the trough or pan is level with the birds back at all times.
- The feed level within the feeders should be set so that feed is readily available while spillage is minimized.
- **Never allow the feeders to run empty at any time.**

V. Seven-day Bodyweight and Feed Conversion Check:

Seven-day weights and feed conversion are excellent overall indicators of how successful the brooding management has been. Failure to achieve optimal seven-day weights and feed conversion will result in poor broiler performance.

4.2 POST-PLACEMENT HOUSE PREPARATION EVALUATION

Two very important “Chick Checks” should be made 24 hours post-placement. These two checks are simple & effective ways to evaluate pre-placement management:

“CHICK CHECK 1” - 4 to 6 Hours Post-Placement

- Sample 100 chicks per brood area.
- Check: temperature of feet against neck or cheek.
- If the feet are cold, reevaluate pre-heating temperature.
- Results of Cold Litter:
    1. Poor early feed intake
    2. Poor growth
    3. Poor uniformity

An excellent indicator of floor temperature is the temperature of the chick’s feet. If the chick’s feet are cold, the internal body temperature of the chick is also reduced. Cold chicks will be seen huddling with reduced activity and resulting in reduced feed and water intake and therefore reduced growth rate. By placing the feet against your neck or cheek one can readily learn how warm or cold the chick is. If they are comfortably warm, the chicks should be actively moving around the brooding area.

“CHICK CHECK 2” - 24 Hours Post-Placement

The crops of chicks should be checked the morning after placement to ensure they have found feed & water. At this time, a minimum of 95% of the crops should feel soft & pliable indicating chicks have successfully located feed and water. Hard crops indicate chicks have not found adequate water and water availability should be checked immediately. Swollen and distended crops indicate chicks have located water but insufficient feed. In this case the availability and consistency of the feed should be immediately evaluated.

- Sample 100 chicks per brood area.
- The desirable result is 95% crops with both feed & water.
- Evaluate crop fill & indicate results on form as below:

Crop Fill	**Full - Pliable** *Feed & Water*	**Full - Hard** *Only Feed*	**Full - Soft** *Only Water*	**Empty**
Evaluation	95%	?	?	?

5. GROWING PHASE

Broiler producers must place added emphasis on supplying a feed that will produce a product to meet their customers' specifications. Growth management programs optimizing flock uniformity, feed conversion, average daily gain and livability are most likely to produce a broiler that meets these specifications and maximizes profitability. These programs may include modification of lighting and/or feeding regimes.

5.1 UNIFORMITY

Uniformity is a measure of the variability of bird size in a flock. This can be measured by various means, such as:

1. Visual and subjective evaluation
2. By weight +/- 10%
3. By coefficient of variation
4. Post slaughter – carcass yield evaluations

How to calculate flock uniformity:

- Divide the house into three sections.
- Take a random sample of approximately 100 birds from each section or 1% of the total population.
- Weigh and record the individual weights.
- It is important to weigh all birds within the catch pen, excluding culls.
- Count the number of birds 10% either side of the average body weight of the 100 bird sample.
- The number as a percentage of the sample represents the flock uniformity percentage.

Coefficient of Variation (CV)

The coefficient of variation (CV) is commonly used to describe variability within a population.

A low CV indicates a uniform flock. A high CV indicates an uneven flock.

CV	Uniformity	Evaluation
8	80%	Uniform
10	70%	Average
12	60%	Poor Uniformity

Variation can be expressed either in terms of:

- average bird weight
- standard deviation of body weight
- coefficient of variation in body weight

The coefficient of variation is a comparative measure of variation that allows the change in variation during the growth of the flock to be monitored. The standard deviation is a measure of how widely values are dispersed around the average value (the mean). In a normal flock, approximately 95% of the individual birds will fall in a band +/- two standard deviations either side of the average body weight.

CV% = [Standard deviation (g) ÷ average body weight (g)] x 100

The following table gives an approximation of flock uniformity (% within +/- 10%) into CV%.

% Uniformity	CV (%)
95.4	5
90.4	6
84.7	7
78.8	8
73.3	9
68.3	10
63.7	11
58.2	12
55.8	13
52.0	14
49.5	15
46.8	16

5.2 TEMPERATURE

Activity Check: Every time you enter a poultry house you should always observe the following activities:

- Birds eating
- Birds drinking
- Birds resting
- Birds playing
- Birds "talking"
- Birds should never be huddling

Temperature/humidity guide:

Age - days	Relative Humidity %	Temperature °C (F) for chicks from 30 week old parent flocks or younger	Temperature °C (F) for chicks from 30 week old parent flocks or older
0	30-50	34 (93)	33 (91)
7	40-60	31 (88)	30 (86)
14	40-60	27 (81)	27 (81)
21	40-60	24 (75)	24 (75)
28	50-70	21 (70)	21 (70)
35	50-70	19 (66)	19 (66)
42	50-70	18 (64)	18 (64)

- **If humidity is less than above, increase temperature 0.5 to 1 ºC (1 ºF). If humidity is greater than above, reduce house temperature by 0.5 to 1 ºC (1 ºF). Always use birds' behavior and effective temperature as the ultimate guide to determine the correct temperature for the birds.**
- Chicks from smaller eggs (younger breeder flocks) require higher brooding temperatures because they produce less heat about 1 ºC for the first seven days.

Temperature with radiant spot brooders

Age Days	Temperature under brooder-Celsius (F)	Temperature edge of the brooder-Celsius (F)	Temperature 2m from the edge of the brooder-Celsius (F)	Relative Humidity %
0	33 (91)	31 (88)	29 (84)	55-65
7	30 (86)	28 (82)	26 (79)	55-65
14	28 (82)	26 (79)	25 (77)	60-70
21	26 (79)	25 (77)	25 (77)	60-70
28	23 (77)	23 (73)	23 (73)	60-70

5.3 LIGHTING PROGRAMS

Lighting programs are a key factor for good broiler performance and flock welfare. Lighting programs are typically designed with changes occurring at predetermined ages and tend to vary according to the final target market weight of the broilers. Lighting programs designed to prevent excessive growth between 7 and 21 days have been shown to reduce mortality due to ascites, sudden death, leg problems and spiking mortality. Research indicates that lighting programs which include 6 hours of continuous darkness will improve the development of the immune system.

One standard lighting program will not be successful for all parts of the world. Therefore, the lighting program recommendations listed in this guide should be customized based on the environmental conditions, house type and overall stockman objectives. Lighting programs inappropriately employed may impair average daily gain (ADG) and compromise flock performance. Careful observations of flock performance, nutrient density and intake are also important in designing lighting programs. If accurate ADG information can be acquired, a program based on average weight gains is preferred.

The intensity and distribution of light alters broiler activity. Correct stimulation of activity during the first 5-7 days of age is necessary for optimal feed consumption, digestive and immune system development. Reducing the energy required for activity during the midportion of the growing period will improve production efficiency. Uniform distribution of light throughout the house is essential to the success of any lighting program.

It is recommended that 25 lux (2.5 foot-candles) in the darkest part of the house, as measured at chick height, be used during brooding to encourage early weight gains. Optimum light intensity at floor level should not vary by more than 20%. After 7 days of age, or preferably at 160 grams body weight, light intensities should be reduced gradually to 5-10 lux (0.5-1 fc).

5.3.1 KEY POINTS TO CONSIDER WHEN USING A LIGHTING PROGRAM

- Test any lighting program before making it firm policy.
- Provide 24 hours light on the first day of placement to ensure adequate feed and water intake.
- Turn the lights off on the second night to establish when that **off** time will be. Once set, this time must never change for the life of the birds.
- Once the switch **off** time has been established for the flock, any adjustment should be by adjusting the **on** time only. Birds soon get used to when the **off** time is approaching and will “crop-up” and drink before the lights go **off**.
- Use a single block of darkness in each 24-hour period.
- Start increasing the dark period when the birds reach 100-160 grams.
- If partial house brooding is practiced, delay dimming until the full house is utilized..
- Allow the birds to feed ad libitum to ensure they go into the dark period full of feed and water and can eat and drink immediately when the lights turn back on. This helps prevent dehydration and reduces stress.
- As much as is possible, the darkness should be provided at night to ensure the dark periods are truly dark and that adequate inspection of the flock is possible during the day.
- The birds should be weighed at least weekly and on days that the program is scheduled to be adjusted. The lighting program should be adjusted according to the average weight of the birds. Past experience of a particular farm’s performance should also be considered.
- The length of the dark period should be increased **in steps** and **not** in gradual hourly increases. (see programs)
- Reducing the dark period before catching reduces “flightiness.”
- If progressive depopulation is practiced it is good policy to reintroduce 6 hours darkness the first night after depopulation.
- Reduce the darkness in times of warm weather if the birds are being stressed during the day and feed intake has been reduced.
- In **wintertime** coincide the **off time** with dusk so the birds are awake during the coldest part of the night.
- In the **summer time** coincide the **on time** with sunrise.
- Make sure that there are no drafts or wet litter at the end of the house where demand pans are installed. This could result in empty feeding systems leading to panic and scratching.
- Do not turn the feed off during the dark period.
- Best to begin increasing/decreasing light prior to on/off periods over a one hour period using a dawn to dusk dimming system.
- Broiler producers with clear curtain housing have limited alternatives. They need to design their lighting programs to coincide with natural daylight.
- 48 hours prior to catch, increase light intensity to 10/20 lux to acclimate the birds to catching - only if daylight catching is practiced!

5.3.2 THREE LIGHTING PROGRAMS

1. STANDARD LIGHTING PROGRAM - OPTION 1

- Slaughter weight: <2.5 kg (5.5 lbs)

Age days	Hours dark	Hours change
0	0	0
1	1	1
100-160 grams	**6**	**5**
Five days before kill	5	1
Four days before kill	4	1
Three days before kill	3	1
Two days before kill	2	1
One day before kill	1	1

2. STANDARD LIGHTING PROGRAM - OPTION 2

- Slaughter weight: 2.5 - 3.0 kg (5.5 - 6.6 lbs)

Age days	Hours dark	Hours change
0	0	0
1	1	1
100-160 grams	**9**	**8**
22	8	1
23	7	1
24	6	1
Five days before kill	5	1
Four days before kill	4	1
Three days before kill	3	1
Two days before kill	2	1
One day before kill	1	1

3. STANDARD LIGHTING PROGRAM - OPTION 3

- Slaughter weight: >3.0 kg (6.6 lbs)

Age days	Hours dark	Hours change
0	0	0
1	1	1
100-160 grams	**12**	**11**
22	11	1
23	10	1
24	9	1
29	8	1
30	7	1
31	6	1
Five days before kill	5	1
Four days before kill	4	1
Three days before kill	3	1
Two days before kill	2	1
One day before kill	1	1

5.4 LIGHTING PROGRAM BENEFITS

- A period of darkness is a natural requirement for all animals.
- Energy is conserved during resting, leading to an improvement in feed conversion.
- Mortality is reduced, and skeletal defects are reduced.
- The light/dark period increases melatonin production, which is important in immune system development.
- Bird uniformity is improved.
- Growth rate can be equal to or better than that of birds reared on continuous light when compensatory gain is attained.
- Local government legislation may affect the lighting program that can be used. All operations must comply fully with local animal welfare regulations.

6. VENTILATION MANAGEMENT

6.1 MINIMUM VENTILATION

Definition:
The minimum amount of ventilation (air volume) required to maintain full genetic potential by ensuring an adequate supply of oxygen while removing the waste products of growth and combustion from the environment. The requirements of a correctly operated minimum ventilation system include:

- Moisture removal.
- The provision of oxygen to meet the birds metabolic demand.
- The control of relative humidity.
- The maintenance of good litter conditions.

A common misconception is that minimum ventilation is not required in warm climates. Summer ventilation (tunnel ventilation) procedures can be used in moderation in place of minimum ventilation.

This system should be independent of any temperature control system and works best if operated by a cycle timer with a temperature override.

The Timer:
- A 5-min. cycle period is preferred; the cycle time should not exceed 10 min.
- The minimum run time on the system must be at least 20% of the time.
    - 10-min. cycle: 2 min. on, 8 min. off.
    - 5-min. cycle: 1 min. on, 4 min. off.
- Anytime the air quality begins to deteriorate, the run time must be increased with the total cycle time remaining the same.

The minimum ventilation system is calculated in two stages: first stage and second stage minimum ventilation.

A. FIRST STAGE MINIMUM VENTILATION:
- Fans should operate on a timer and not a thermostat.
- These fans should be fixed volume and not variable speed.
- The capacity of fans on the timer should be able to give a total air exchange every 8 min.
- The number of fans required for an air exchange every 8 min. is as follows:
  House Volume (m^3) ÷ available Fan Capacity (m^3/min)
  House Volume (ft.^{3}) ÷ available Fan Capacity (ft.^{3}/min or cfm)

House Volume Calculation:

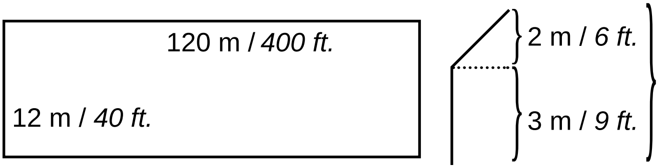
- House Volume: length (m/ft.) x width (m/ft.) x average height (m/ft.) = House Volume (m^3/$ft.^3$)
- **Note:** Average Height = height of side wall + ½ height from eave to peak of the roof.

Fans Used:

- 900 mm or 36 in., working capacity of 345 m^3/min or 12,180 cfm
- 1,200 mm or 48 in., working capacity of 600 m^3/min or 21,180 cfm

Sample Dimensions:

- House dimensions: 120 m long, 12 m wide & 4 m average height.
- House dimensions: 400 ft. long, 40 ft. wide & 12 ft. average height.



Average height =
3 m + (0.5 x 2 m) = 4 m

Average height =
9 ft. + (0.5 x 6 ft.) = 12 ft.

Note: All examples that follow are in metric, but apply equally to the house dimensions noted above.

Calculation - First stage minimum ventilation:

- House volume = 120 m x 12 m x 4 m = 5,760 m^3
- Fan capacity for a 900 mm (36 in) fan = 345 m^3/min
- House air exchange every 8 min.
- 5,760 m^3 ÷ 8 = 720 m^3/min
- 720 m^3/min ÷ 345 m^3/min = 2.08 fans or 2 fans (900 mm fans)

B. SECOND STAGE MINIMUM VENTILATION

The second stage minimum ventilation should be able to achieve an air exchange every 5 min. and run on a temperature control only and not on a timer. These fans should be 900 mm fixed volume and not variable speed. The total number of fans needed on this second stage minimum ventilation is as follows:

Calculation - Second stage minimum ventilation:

- House Volume = 120 m x 12 m x 4 m = 5,760 m^3
- Fan capacity for a 900 mm (36 in) fan = 345 m^3/min
- House air exchange every 5 minutes.
- 5,760 m^3 ÷ 5 = 1,152 m^3/min
- 1,152 m^3/min ÷ 345 m^3/min = 3.3 fans or 4 fans (900 mm fans)

The maximum level of CO_2 at any time in the chicken house is 3,000 ppm. If the house environment exceeds 3,000 ppm of CO_2, then the ventilation rate must be increased.

Circulation fans can assist in reducing the temperature difference between the ceiling and the floor and therefore reduce heating costs.

Placement rules and operation of circulation fans:

- Fans should be installed in a single row close to the ceiling.
- Fan size is 45 cm (18 in).
- Fans should blow from the center of the house to the end.
- 10 meters (33 feet) apart in the center.
- A fan every 20 meters (66 feet).
- Fans should be running 100% of the time.

6.2 NEGATIVE PRESSURE - KEY REQUIREMENT FOR MINIMUM VENTILATION

The most efficient way to accomplish correct air distribution for minimum ventilation is by using a negative pressure ventilation system. This system should direct the incoming air into the peak of the house. The pressure drop across the inlets should be adjusted to ensure that the incoming air reaches the peak of the house where the heat has accumulated. The pressure drop across the inlets should be adjusted to ensure that the incoming air reaches the peak of the house where the heat has accumulated. The pressure drop selected will depend on the width of the house or how far the air is to travel once it enters the house. Correct air pressure is achieved by matching the inlet area and the fan capacity.

A common misconception is that increasing the pressure differential by restricting the inlet area will increase the volume of air entering the house. Actually, the opposite occurs. As negative pressure increases, incoming air speed increases at the point of entry, but the resulting greater negative pressure lowers fan capacity and reduces the total volume of air moving through the hose. This volume decrease is seen especially when using direct drive exhaust fans.

In order to effectively generate a negative pressure system, a controlled environment must be created. Air seeks the point of least resistance and air leaks will generate incorrect airflow distribution. The house needs to be as air tight as possible. Typically, leaks are located at the ridge, close to the fans and/or close to the floor. Fan housings need to be sealed to maximize their performance. Back draft shutters must be installed to prevent down drafts and fan belts should be maintained at the correct tension to maximize the fan efficiency.

A well sealed house with the inlets closed and a single 1.2 m fan in operation should achieve a static pressure of at least 37.5 Pa. If the static pressure is less than 25 Pa then the leaks need to be addressed immediately and the house sealed.

6.3 INLETS

Air inlets should be pressure controlled to maintain a constant air speed throughout the ventilation stages. These inlets should direct the air into the peak of the house and close when the fans are off. The minimum ventilation inlets should completely seal when closed. When open, the air should only enter through the top of the inlet and not from the sides or through the bottom of the inlet. Inlets that leak air through the sides and bottom will result in cold air being directed to the floor, resulting in chilled birds and condensation forming on the litter.

In open truss houses, the angle of the inlet opening must be such that the air is not directed onto a purling. Obstructions such as a purling or electrical conduit should be avoided because they interrupt the air flow, forcing the air to the floor.

The inlets need to open enough to achieve the required static pressure and airflow. A minimum opening of 2.5 cm - 5 cm (1 - 2 in.) is required.

Inlet drive motors should be installed in the center of the side wall to reduce inlet opening variation. Cables used to control inlets often stretch causing varying inlet opening and poor air distribution. Solid 8 mm (0.3 in.) steel rods expand less, making them the best option for long houses.

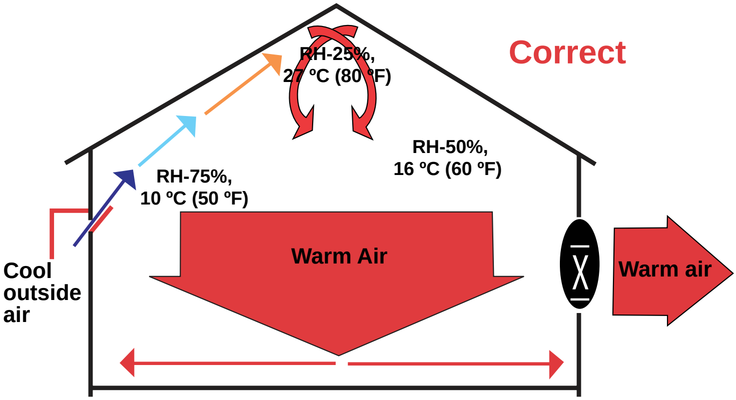
Inlets should be installed 30 cm. (12 in.) below the sidewall eaves and with wind proofing on the outside. Prevailing winds will cause a significant pressure drop inside the house and the cold air entering will drop to floor level. The inlet cover should be at least 30% more than the cross sectional area of the inlet to minimize air restriction. The leeward side of the house will always create a negative pressure on the outside. The windward side of the house will always create a positive pressure on the outside. Wind proofing will prevent heat being drawn out of the house on the leeward side.

Without wind proofing, the mechanical pressure control system of the house cannot properly adjust the pressure or inlet openings to accomplish the correct air speed across the inlets to prevent condensation on the walls and floor or wind chill at bird level.

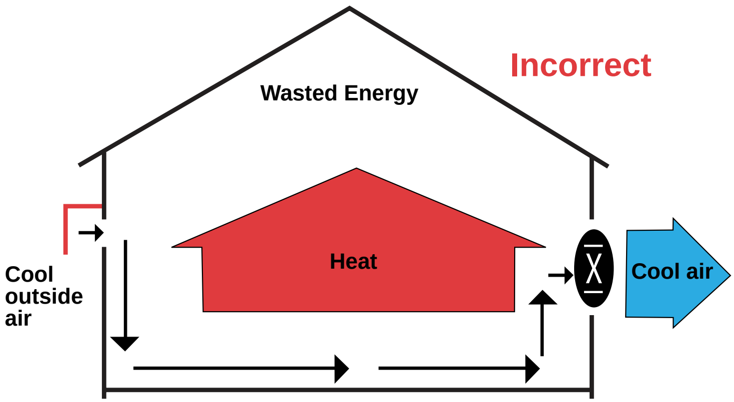
Incoming cold air mixes with the hotter air in the ridge cap. The cold air is heated and expands, increasing its moisture holding capacity and reducing its relative humidity.

The following diagrams illustrate the importance of correct inlet management:

Cross-Flow for Minimum Ventilation



Cross-Flow Ventilation with Low Pressure Drop Across Inlets



The following table can be used as a reference guide for different widths of poultry houses in determining the required inlet air speed, pressure difference and inlet area. The inlet area is dependant on the fan capacity.

Inches of Water	Pascal	Width of House (m/ft)	Air Speed
.03	8	10.0 m (33 ft)	700 fpm 3.50 mps
.04	10	12.0 m (39 ft)	800 fpm 4.00 mps
.08	20	15.0 m (50 ft)	1100 fpm 5.00 mps
.10	26	18.0 m (60 ft)	1250 fpm 6.35 mps
.15	37	21.0 m (69 ft)	1480 fpm 7.50 mps
.17	42	24.0 m (79 ft)	2360 fpm 8.00 mps

Always use a smoke test to assure that the incoming air reaches the center of the house.

6.4 TRANSITIONAL VENTILATION

- **Objective:** to increase house air exchange without creating high air speeds across the birds.
- The transitional ventilation typically includes 40% - 50% of the total tunnel ventilation capacity.
- These fans operate on a thermostat.
- These fans have an operating capacity able to ensure a house air exchange every 2 min.
- These fans use side wall inlets evenly distributed on each side wall the full length of the house. The inlets are most efficient when controlled by negative pressure.
- The inlets should direct the air into the peak of the house to prevent cold air movement across the floor and the chicks.
- With fans on one end of the house and inlets evenly placed on each side of the house, the maximum air velocity across the birds will be 25% of that achieved during full tunnel ventilation.
- This system gives excellent temperature control and reduced risk of chilling of the chicks and is a valuable part of any ventilation system.
- The final stage of transition or full transition, the tunnel inlet will open.

Calculation - Transitional ventilation:

- House Volume = 120 m x 12 m x 4 m = 5,760 m^3
- Fan capacity for belt drive 1.2 m fan = 600 m^3/min
- House air exchange every 2 min
- 5,760 m^3 ÷ 2 = 2,880 m^3/min
- 2,880 m^3/min ÷ 600 m^3/min = 4.8 fans or 5 fans (1.2 m fans)

6.5 TUNNEL VENTILATION

Tunnel ventilation systems are used to moderate the effects of seasonal temperature fluctuations and are particularly effective during hot weather. In tunnel ventilation systems, all exhaust fans are placed at one end of the house and air intakes at the opposite end. As a general guideline, the air is drawn at a velocity of 3.00 m/s (600 ft./min) through the length of the house removing heat, moisture and dust.

The airflow creates a wind-chill effect, which can reduce the effective temperature by 5 - 7 °C (10-12 °F). House effective temperatures should be maintained below 30 °C (86 °F) and a complete air exchange should occur within one min.

Calculation - Tunnel Ventilation:

STEP 1: DETERMINE BASIC HOUSE DIMENSIONS

- House capacity: 120 m long x 12 m wide x 4 m avg. height = 5,760 m^3
- Cross section: 12 m wide x 4 m average height = 48 m^2
- Required Airspeed: 3.0 m/s
- Required Air Exchange: less than 1 min

STEP 2: FAN CAPACITY REQUIRED FOR MAXIMUM AIRSPEED OF 3.0 M/S

- Required fan capacity: 48 m^2 x 3.0 m/s = 144 m^3/s
- Number 1.2 m fans required: 144 m^3/s ÷ 10 m^3/s = 14 fans

Note: The fans most suitable for a tunnel ventilation system are high capacity belt driven 1.2m (48”), 1.3m (52”) or 1.4m (54”) diameter fans. In modern broiler houses with high windspeed, tunnel fans operate under high static pressure.

STEP 3: IS THE AIR EXCHANGE < 1 MIN?

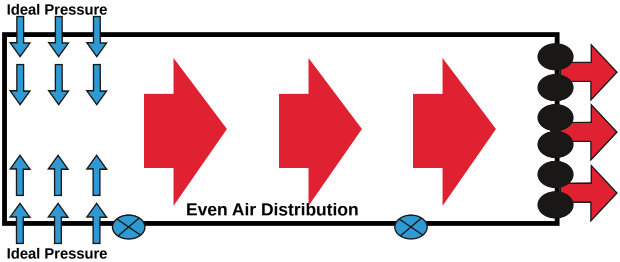
- Air Exchange: House Volume ÷ Total Fan Capacity
  5,760 m^3 ÷ (14 x (10 m^3/s x 60s))
  = 5,760 m^3 ÷ (14 x 600 m^3/min)
  = 0.69 min

STEP 4: IS THE AIR SPEED 3.0 M/S?

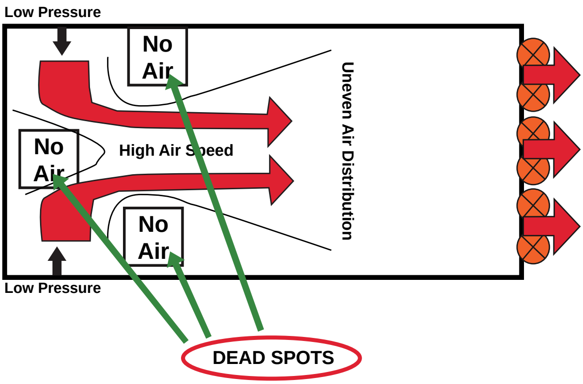
- Air Speed: Total Fan Capacity (m^3/s) ÷ Cross Section Area (m^2)
  (14 x 10 m^3/s) ÷ 48 m^2 = 2.92 m/s

The following two diagrams illustrate the importance of maintaining the correct airspeed and negative pressure drop at the tunnel inlet curtain. Low inlet airspeed will result in “dead spots.”

Tunnel Ventilation



LOW Inlet Air Speed < 2.5 m/s or 500 fpm



6.6 EFFECTIVE TEMPERATURE

Effective temperature is the combined effect of the following factors:

- Ambient temperature
- Relative Humidity %
- Air Speed m/s
- Stocking density
- Feather cover
- Radiant heat

During high temperatures, heat loss associated with non-evaporative cooling declines as the temperature differential between the bird and the environment is reduced. Evaporative heat loss becomes the prominent mode of heat loss during heat stress. High relative humidity decreases the amount of water evaporation. **If relative humidity cannot be reduced below 70%, the only solution is to maintain an air velocity of at least 3.0 m/s (600 ft./min) or more.**

The table below gives an indication of the effective temperature reductions possible for different combinations of ambient temperature, relative humidity (RH) and air speed.

Note: The table applies to birds less than 25 days – without full plumage. Once fully feathered we rely on airspeed to remove heat from under and around the bird.

Temp ºF	Temp ºC	Relative Humidity %				Airspeed m/s					
		30%	50%	70%	80%	0 m/s	0.5 m/s	1.1 m/s	1.5 m/s	2.0 m/s	2.5 m/s
95	35	**30%**				35	31.6	26.1	23.8	22.7	22.2
95	35		**50%**			35	32.2	26.6	24.4	23.3	22.2
95	35			**70%**		38.3	35.5	30.5	28.8	26.1	25
95	35				**80%**	40	37.2	31.1	30	27.2	25.2
90	32.2	**30%**				32.2	28.8	25	22.7	21.6	20
90	32.2		**50%**			32.2	29.4	25.5	23.8	22.7	21.1
90	32.2			**70%**		35	32.7	28.8	27.2	25.5	23.3
90	32.2				**80%**	37.2	35	30	27.7	27.2	26.1
85	29.4	**30%**				29.4	26.1	23.8	22.2	20.5	19.4
85	29.4		**50%**			29.4	26.6	24.4	22.8	21.1	20
85	29.4			**70%**		31.6	30	27.2	25.5	24.4	23.3
85	29.4				**80%**	33.3	31.6	28.8	26.1	25	23.8
80	26.6	**30%**				26.6	23.8	21.6	20.5	17.7	17.7
80	26.6		**50%**			26.6	24.4	22.2	21.1	18.9	18.3
80	26.6			**70%**		28.3	26.1	24.4	23.3	20.5	19.4
80	26.6				**80%**	29.4	27.2	25.5	23.8	21.1	20.5
75	23.9	**30%**				23.8	22.2	20.5	19.4	16.6	16.6
75	23.9		**50%**			23.9	22.8	21.1	20	17.7	16.6
75	23.9			**70%**		25.5	24.4	23.3	22.2	20.0	18.8
75	23.9				**80%**	26.1	25	23.8	22.7	20.5	20
70	21.1	**30%**				21.1	18.9	17.7	17.2	16.6	15.5
70	21.1		**50%**			21.1	18.9	18.3	17.7	16.6	16.1
70	21.1			**70%**		23.3	20.5	19.4	18.8	18.3	17.2
70	21.1				**80%**	24.4	21.6	20	18.8	18.8	18.3

At temperatures in excess of 32 °C, the use of wind chill becomes less effective. The only way to effectively cool birds 2 kg or more, exposed to temperatures in excess of 38 °C, is through the use of evaporative cooling.

The key points of tunnel ventilation are:

- Seal properly the house
- Air pressure
- Air speed
- Air cooling

6.7 EVAPORATIVE COOLING

Evaporative cooling pads are designed to create restriction of air entering the house and to evaporate moisture off the surface of the pad. Evaporation is achieved by heat and air velocity. The kinetic energy of a molecule is proportional to its temperature; evaporation proceeds more quickly at higher temperature. As the faster-moving molecules escape, the remaining molecules have lower average kinetic energy, and the temperature of the liquid thus decreases. This phenomenon is called evaporative cooling. The energy released during evaporation reduces the air temperature. This is extremely effective at low relative humidity.

In conjunction with tunnel ventilation, evaporative cooling pads and/or fogging systems are incorporated to reduce house temperature. The pads should be wet 100% and the dog house also must be insulated.

The following table is a guide for the potential cooling effect using evaporative cooling at a wide range of temperatures and humidity.

Example: At 30 °C & 36% RH, the potential reduction in house temperature is 10.6 °C (19 °F).

Dry Bulb Temperature														
ºC	ºF	Relative Humidity%												
21.1	70	86	77	68	59	51	44	36	29	22	15	9	3	0
22.2	72	86	77	69	61	53	45	38	31	24	18	12	6	0
23.3	74	86	78	69	61	54	47	39	33	26	20	14	8	3
24.4	76	87	78	70	62	55	48	41	34	28	22	16	11	5
25.6	78	87	79	71	63	56	49	43	36	30	24	18	13	8
26.7	80	87	79	72	64	57	50	44	38	32	26	20	15	10
27.8	82	88	80	72	65	58	51	45	39	33	28	22	17	12
28.9	84	88	80	73	66	59	52	46	40	35	29	24	19	14
30	86	88	81	73	66	60	53	47	42	36	31	26	21	16
31.1	88	88	81	74	67	61	54	48	43	37	32	27	22	18
32.2	90	89	81	74	68	61	55	49	44	39	34	29	24	19
33.3	92	89	82	75	68	62	56	50	45	40	35	30	25	21
34.4	94	89	82	75	69	63	57	51	46	41	36	31	27	22
35.6	96	89	82	76	69	63	58	52	47	42	37	32	28	24
36.7	98	89	83	76	70	64	58	53	48	43	38	34	29	25
37.8	100	89	83	77	70	65	59	54	49	44	39	35	30	26
38.9	102	90	85	78	72	67	62	56	51	46	42	36	32	28
40	104	90	85	78	72	67	62	56	52	47	43	38	33	29
41.1	106	90	85	78	73	67	62	57	52	47	43	39	34	30
42.2	108	90	85	78	73	67	62	57	53	48	44	40	35	32
43.3	110	91	85	79	73	68	63	57	53	49	45	41	37	33

Potential Cooling for a Given Temperature and Relative Humidity

DROP in F	3	5	7	9	11	13	15	17	19	21	23	25	27
DROP in C	1.7	2.8	3.9	5.0	6.1	7.2	8.3	9.4	10.6	11.7	12.8	13.9	15.0

6.7.1 PUMP MANAGEMENT

Maximum evaporation is achieved without the continuous pumping of water onto the pads. The pumps should only run to provide enough pad moisture to create maximum water evaporation. This is accomplished by operating the pumps with a thermostat and a humidistat which controls moisture addition and prevents the build up of high humidity. If more water is added to the house environment than the ventilation system has the ability to remove, wet litter problems, high relative humidity and higher effective temperatures will occur.

The temperature sensor should be in the last third of the house (fan end) at just above bird height. The humidity sensor should be in the first third of the house (cooling pad end), 1.3 m (4 ft.) above the floor.

Very low humidity is conducive to excellent evaporation and therefore cooling. The pumps should never run 100% of the time. When outside relative humidity is high the pumps should operate for a short period of time, just wetting the pads. The pumps should be turned off until the pads begin to dry. This cycle must be repeated. As the humidity drops, the pumps can run more often and for a longer period.

Note: Evaporative cooling should not be used when the relative humidity is above 75%.

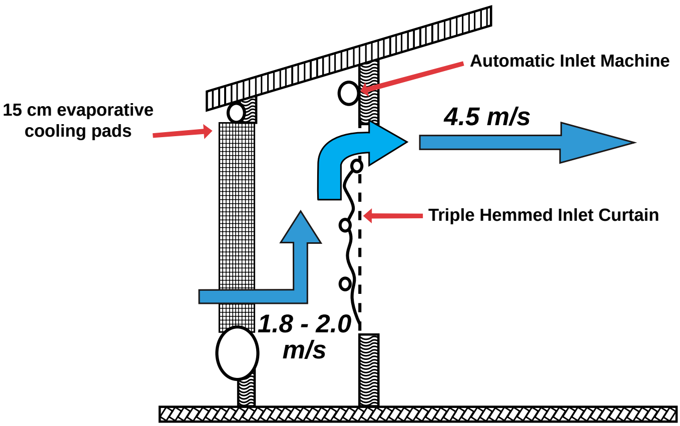
6.7.2 EVAPORATIVE PAD DESIGN

The pad space surface area must match the fan capacity to ensure correct airflow & evaporation. There are three types of evaporative pads commonly used:

- 5 cm (2 in.) fogger pads
- 10 cm (4 in.) recirculation pads (occasionally used in fogging systems)
- 15 cm (6 in.) recirculation pads

The following is the optimal evaporative pad house design. The air speed through the inlet is based on a 12 m wide house (air speed differs according to the width of the house - see negative pressure scale table on page 31).

Evaporative Pad House Design



Important design requirements:

- A triple hemmed curtain is required. The curtain needs to be sealed - see section 1.2 (page 2) on curtain design.
- If using tunnel inlet doors, they need to be well sealed along the perimeter.
- The roof of the cool pad house should be insulated.
- The cool pad house should be a minimum of 0.6-1 m (2 - 3 ft.) wide. The cooling pads should be at least 30 cm (12 in.) from the inlet curtain.
- The water recovery system must be above ground to ensure water is warm and provide easy access for cleaning.
- Protect standing water in tank from direct sunlight (tank lid) to reduce algae growth.
- Install the pump in the middle of the pads to improve the uniformity of the pressure and the wetting of the pads.

6.7.3 EVAPORATIVE PAD MANAGEMENT

- The evaporative system should never run before all the tunnel fans are working to insure correct evaporation and air distribution.
- Evaporative cooling should only be used above 28 °C. (82 ºF).
- Evaporative cooling should not be used before the flock is 28 days of age.
- The curtains should never be fully opened - maximum curtain inlet opening: 0.75 - 1 m (2.5 - 3 ft.)
- Pad system should be flushed weekly.
- A cleaning program should be in place every turnaround.

6.7.4 EVAPORATIVE PAD AREA REQUIREMENT CALCULATION

Example:

COOL PAD AIR SPEED REQUIREMENT:

- 15 cm (6 in.) pad - <1.8 m/s (<350 ft./min)
- 10 cm (4 in.) pad - <1.25 m/s (<250 ft./min)
- 5 cm (2 in.) pad - <0.75 m/s (<150 ft./min)

STEP 1: DETERMINE BASIC HOUSE DIMENSIONS

- House capacity: 120 m long x 12 m wide x 4 m avg height = 5,760 m^3
- Cross section: 12 m wide x 4 m average height = 48 m^2
- Required Airspeed: 3.0 m/s
- Required Air Exchange: less than 1 min

STEP 2: WHAT IS THE TOTAL FAN CAPACITY NEEDED?

- Total fan capacity: 48 m^2 x 3.0 m/s = 144 m^3/s
  (520 $ft.^2$ x 600 ft./min = 312,000 $ft.^3$/min)

STEP 3: WHAT IS THE TOTAL PAD AREA REQUIRED?

- 144 m^3/s ÷ 1.8 m/s = 80 m^2 pad area
  (312,000 $ft.^3/min$ ÷ 350 ft./min = 891 $ft.^2$ pad area)
- 80 m^2 ÷ 1.5 m (standard pad height) = 53 m pad
  (891 $ft.^2$ ÷ 5 ft. (standard pad height) = 178 ft. pad)
- OR 26.5 m per side
  (OR 89 ft. per side)

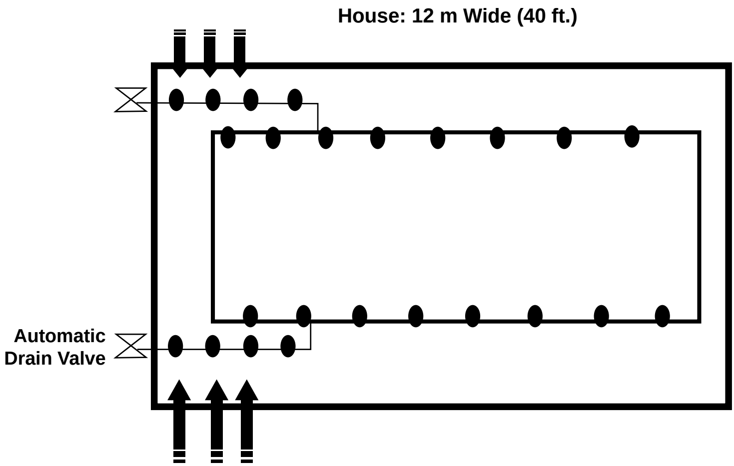
6.7.5 COMMON VENTILATION CAUSES FOR WET LITTER AND HIGH HUMIDITY

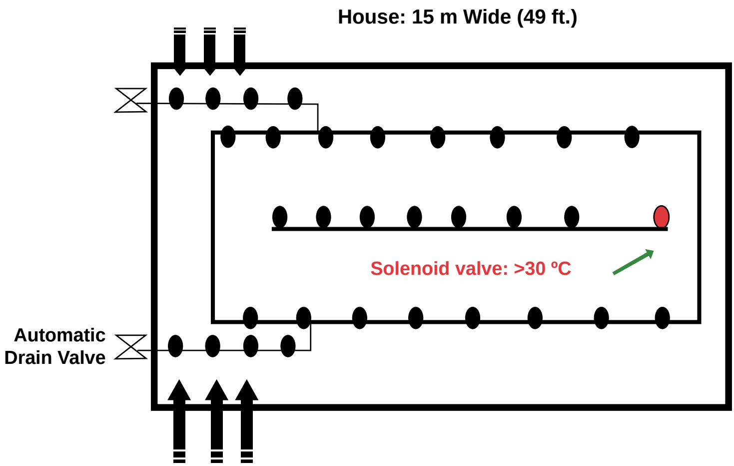
- Air speed through pads too high or low. Inlet curtain opening needs adjustment.
- Not enough pad area for fan capacity.
- Pads are dirty and blocked.
- Running the pumps with too low air speed.
- Running pumps when temperature is below 28 °C (82 ºF).
- Running pumps when relative humidity is above 75%.
- Pads installed upside down - steepest angle of flutes must face the ground on the outside of the house.
- Pump run time excessive - pads completely saturated.

6.8 FOGGING SYSTEMS

- In houses less than 14 m (45 ft.) wide there should be two rows of nozzles throughout the house with each line being 1/3 the distance from each side wall.
- Low pressure fogging systems operate at 7.6 l/hour (2 gal/hour).
- The nozzles are installed pointing straight down at 3.1 m (10 ft.) centers on each line and staggered from side-to-side throughout the house.
- The fogging lines should be installed in a loop throughout the house.
- An automatic drain valve should be installed on each line to drain the water to the outside of the house when the pump is off. Drain valves prevent dripping when the system is not in operation.
- In tunnel ventilated houses, a line should be teed off the two main lines in front of the tunnel inlet; 1.2 m (4 ft.) from the inlet opening with 7.6 L/hour (2 gal/hour) nozzles on 1.5 m (5 ft.) centers.
- There should be a 2 cm (3/4 in.) water supply line from the pump to the main fogging line.
- The pump should be controlled by both temperature and humidity.
- Foggers should start running at 28 °C (82 °F).
- Low pressure fogging systems operate at 7-14 bar (100-200 psi) producing a droplet size greater than 30 microns.
- High pressure fogging systems operate at 28-41 bar (400-600 psi) producing a droplet size of 10-15 microns. This works better in high humidity conditions.

Moisture should never be directly added to the inlet opening when the air velocity is more than 3.0 m/s (600 ft./min) - the inlet area nozzles should be positioned where the air velocity is under 3.0 m/s (600 ft./min) to prevent floor and bird wetting. If the mist from one nozzle combines with that of the next nozzle, there may be too many nozzles or the system should not be running. This situation will cause high humidity and possibly increase bird mortality at the fan end of the house.





Recommended installation specifications:

- Pump - mainline: 2 cm (3/4 in.) pipe.
- Inside Loop - 1.25 cm (1/2 in.) pipe.
- Loop configuration is needed to avoid dripping during operation. Drain valves prevent dripping while system is off.

6.9 NATURAL VENTILATION

Natural ventilation is common in temperate regions where the climatic conditions are similar to the desired production requirements. It is not recommended to employ this system in regions with climatic extremes.

Successful natural ventilation is dependent on house location. Houses should be built in an east to west orientation to avoid solar heating of the sidewalls during the hottest part of the day. Prevailing winds should be used advantageously. A reflective roof surface with a minimum insulation R-value of 20-25 (see insulation values, pages 2-3) and sufficient overhang needs to be considered.

6.9.1 MANAGEMENT TECHNIQUES IN HOT CONDITIONS

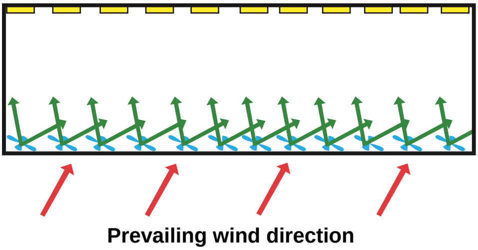
1. Walk the birds gently and regularly to encourage air circulation around the birds and stimulate water consumption.
2. Remove feed from the birds by lifting the feeding system six hours before the hottest part of the day. This removes a potential barrier to air movement and reduces the birds' heat output due to feed metabolism.

Key points when installing cooling fans in a naturally ventilated house:

- Minimum size: not less than 900 mm (36 in.) direct drive fans, with an operating capacity of 5.75 m^3/sec or 345 m^3/min (10,500 cfm) at 50 Pa.
- A 900 mm (36 in.) fan will only draw air from 1 m (3.3 ft.) and move air 12 m (40 ft.). Maximum dispersion that a 900 mm fan will distribute air is 2.2 m (7.2 ft.). The fan should be at least 1 m above the floor.
- Above 2.2 m (7.2 ft.), a hot air pocket is formed.
- Fans should be at an angle of 60° to the side wall. The fans should be mounted at the height of the dwarf wall.
- In hot climates if necessary turn on the fans during the first two weeks to remove heat from the house in sidewall curtain houses with stir fan, the fans should be placed at an angle of 120° to the side wall or close to the roof. Do not generate air speed directly across the birds.
- Maximum distance from the side wall, 1 m (3.3 ft.).
- Fans should be suspended perpendicular and 1 m (3.3 ft.) above the floor.

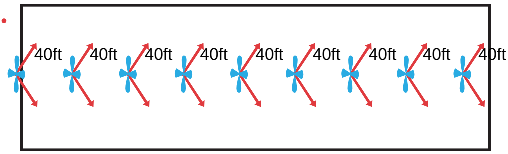
Common fan configurations in naturally ventilated houses until 12 m wide are listed in order of efficiency: 1 = best, 3 = worst. (more than 12 m wide will result in a dead spot at one side of the house as the fans have no power to blow the air above 12 m).

1.



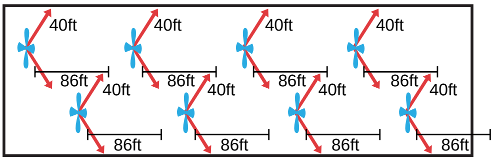
- Fans blowing air across the house from prevailing wind direction.
- Excellent air exchange rate.
- Suspend at an angle of 60º to the sidewall.
- All birds exposed to high air speeds equals total coverage.

2.



- Fans blowing air through center of house.
- First fan MUST be within 1 m (3.3 ft.) from door to ensure fresh air exchange.
- Much lower rate of air exchange than Number 1 configuration.
- Fans must be 12 m (40 ft.) apart.
- All birds exposed to high air speed equals total coverage.

3.



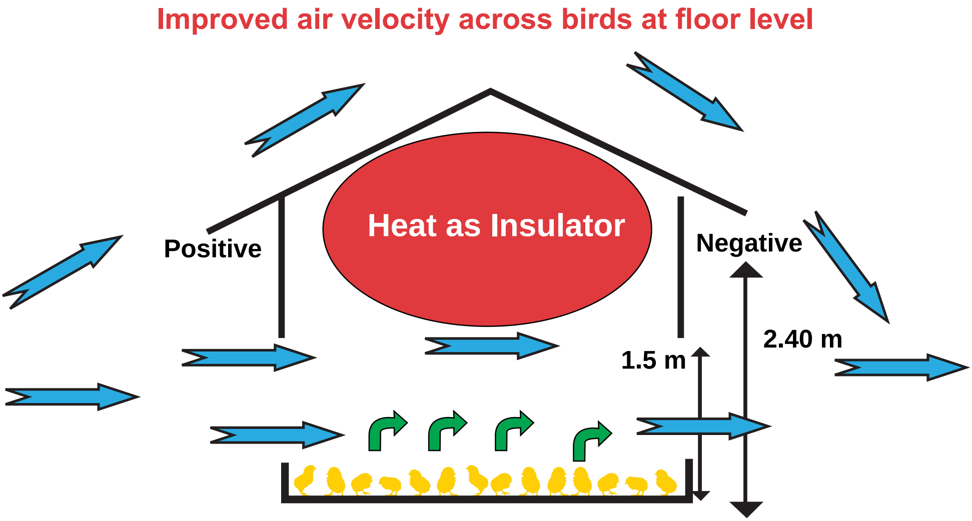
- Fans suspended in "zigzag" pattern.
- NO AIR EXCHANGE.
- Birds exposed to hot and stale air.
- Very poor air speed coverage.

6.9.2 CURTAIN MANAGEMENT TECHNIQUES

In open sided houses, the curtain management is fundamental to obtaining a healthy flock status throughout the whole production period. Good ventilation management requires minimal temperature fluctuations.

1. In different sections of the house you could have temperatures variations.
2. Ventilation at all ages is needed to remove excess heat, humidity and/or CO_2. CO_2 is important in the first week when the house is well sealed. The level of CO_2 should never exceed 3,000 ppm. See air quality guidelines.
3. Good curtain management is vital to avoid respiratory conditions and ascites in cold climatic conditions.
4. Minimize 24 hour temperature fluctuations, especially at night. Better temperature control will improve feed conversion and enhance growth rate.

Improved House Design
Drop Sidewalls Below Eaves



6.9.3 CURTAIN VENTILATION TECHNIQUES

1. Take the wind direction into account in the morning, opening the curtain on the leeward side first.
2. To improve air exchange and increase the air speed entering the house, the curtain on the windward side should be open 25% of the opening on the leeward side.
3. To lower the house air exchange and slow the air entering the house, the windward side should be open four times the leeward side.
4. To achieve maximum air speed across the birds, the curtain should be open the same on both sides and as low as possible.
5. Until 14 days of age, the curtains should be opened to provide air exchange in the house but no air speed at chick or floor level. Air speed across the chicks in the first fourteen days of age leads to chilling, decreased feed and water consumption and increased energy consumption for heat production.
6. Please refer to the mini-tent setup on the brooding page (see item 1.4, page 3).

7. WATER MANAGEMENT

Water is an essential nutrient that impacts virtually all physiological functions. Water comprises 65-78% of the body composition of a bird depending on age. Factors including temperature, relative humidity, diet composition and rate of body weight gain influence water intake. Good water quality is vital to efficient broiler production. Measurements of water quality include pH, mineral levels and the degree of microbial contamination. It is essential that water consumption increases over time. If water consumption decreases at any point, bird health, environment and/or managerial techniques should be re-assessed.

7.1 MINERAL CONTENT

Although broilers are tolerant of some minerals in excess, (calcium and sodium, for example), they are very sensitive to the presence of others. Iron and manganese tend to give water a bitter taste that may decrease consumption. In addition, these minerals support the growth of bacteria. If iron is a concern, filtration systems and chlorination are effective controls. It is advisable to filter the water supply using a filter with a mesh of 40-50 microns. The filter needs to be checked and cleaned at least weekly.

Calcium and magnesium in the water are measured by hardness. These minerals in combination can form scale or deposits that will compromise the effectiveness of a drinker system. This is especially true of closed systems. Water softeners can be incorporated into a system to mitigate calcium and magnesium effects. However, sodium levels should be assessed before a salt-based product is used.

Broiler performance can be impeded by as little as 10 ppm nitrates. Unfortunately, there are currently no cost effective options for removal. Water should be tested for nitrates because elevated levels may indicate sewage or fertilizer contamination.

7.2 MICROBIAL CONTAMINATION

Chronic poor performance may indicate contaminated water and requires prompt testing. When testing water, evaluating the total coliform bacterial count is important, as high levels can cause disease. Assessing the total bacteria through a plate count will reflect the effectiveness of the water sanitation program. Microbial contamination can be introduced from the source of water forward. If an effective water sanitation program is not in place, proliferation of bacteria will readily occur. The water should be tested always when you see noticeable change in color, odor or taste, flooding has occurred near the well, person or animal becomes sick from waterborne disease, maintenance on water supply system, persistently poor performance or loss of pressure in water system.

7.3 WATER SANITATION AND SYSTEM CLEANOUT

A regular water sanitation and water line cleaning program can provide protection against microbial contamination and the build-up of slimy bio-films in water lines. While bio-films may not be a source of problem to birds, once established in water lines, bio-films provide a place for more detrimental bacteria and viruses to hide from disinfectants and also act as a food source for harmful bacteria. Products which contain hydrogen peroxide have proven to be outstanding for the removal of bio-films in water lines. Biofilms have influence on natural contaminants, - iron, sulfur, etc, - vitamins, electrolytes, organic acids, kool-aid, jello, sugar water, vaccines and stabilizers, antibiotics and probiotics.

7.3.1 FLUSHING

All modern poultry watering systems need to be flushed, best practiced on a daily basis to remove bio film, but as a minimum three times per week. High pressure flushing requires having adequate volume and pressure. One to two bars (14-28 psi) of water pressure will create the velocity and turbulence in the pipe work to remove bio film. The open drinker system also must be flushed. In warm/hot climates it might be necessary to flush more than once a day to cool the water temperature. There are automatic flushing systems that make the flushing job easier, saving the grower time and ensuring the water flushing happens.

7.3.2 OXIDATION-REDUCTION POTENTIAL (ORP)

Another important factor is the ORP value of the water. ORP stands for oxidation-reduction potential and it simply refers to the property of sanitizers such as chlorine to be a strong oxidizer. A strong oxidizer literally burns up viruses, bacteria and other organic material present, leaving water microbiologically safe.

An ORP value in the range of 650 mV (Milli volts) or greater indicates good quality water. The lower the value, such as 250 mV, indicates a heavy organic load that will most likely overwhelm the ability of chlorine to properly disinfect the water.

The ORP meter can be a useful tool for identifying and maintaining adequate chlorine supplies without overusing chlorine.

Warning: Swimming pool chlorine test kits do not distinguish between free and bound chlorine. A heavy organic load would result in a greater percentage of bound chlorine resulting in a poor sanitizer even though a test kit might indicate chlorine levels of 4-6 ppm.

Chlorine is most effective when used in water with a pH of 6.0 to 7.0. This pH level results in a greater percentage of active hypochlorous ions that are a strong sanitizer.

Inorganic acids such as sodium bisulfate reduce water pH without tainting the water.

Free chlorine residual levels are not considered useful as sanitizers unless there is at least 85% hypochlorus acid present. Most common source of chlorine includes:

- Sodium hypochlorite (NaOCl, household bleach) increases water pH so it is a poor option as a water sanitizer
- Trichlor (trichoro-s triazinetrione) which is 90% available chlorine and is in the form of tablets which slowly release chlorine over a period of time; these actually reduce water pH so it is a good option as a water sanitizer.
- Chlorine gas is 100% available chlorine and is the purest form of chlorine, but it can be dangerous and is restricted in its use.

7.3.3 pH

- pH is the measure of how many hydrogen ions are in solution and is measured on a scale of 1.0 to 14.0 with 7.0 being neutral.
- pH below 7.0 indicates an acid while numbers above 7.0 indicate an alkaline.
- pH above 8.0 can impact taste by causing bitterness, thus reducing water consumption.
- High water pH can be reduced by using inorganic acids. Organic acids can also negatively affect water consumption and so are discouraged.
- pH impacts water quality and the effectiveness of disinfectants such as chlorine.
- At a pH above 8.0, the chlorine is present mainly as choleric ions, which have very little sanitizing quality.

Impact of pH on the Ratio of Hypochlorus (HOCL) to Chloric Ion (OCL)

pH	% Hypochlorous Acid - HOCl	% Hypochlorite Ion - OCl
8.5	10	90
8.0	21	79
7.5	48	52
7.0	72	28
6.5	90	10
6.0	96	4
5.0	100	0

The ideal drinking water pH for a disinfection water program is between 5 to 6.5

7.4 TOTAL DISSOLVED SOLIDS

Measurement of total dissolved solids (TDS), or salinity, indicates levels of inorganic ions dissolved in water. Calcium, magnesium and sodium salts are the primary components that contribute to TDS. High levels of TDS are the most commonly found contaminants responsible for causing harmful effects in poultry production. The following table provides guidelines suggested by the National Research Council (1974) for the suitability for poultry water with different concentrations of total dissolved solids (TDS), which are the total concentration of all dissolved elements in the water.

Suitability of Water with Different Concentrations of Total Dissolved Solids (TDS)

TDS - ppm	Comments
Less than 1,000	Water suitable for any class of poultry.
1,000 to 2,999	Water suitable for any class of poultry. It may cause watery droppings (especially at higher levels) but with no affect on health or performance.
3,000 to 4,999	Water not suitable for any class of poultry. Can cause watery droppings, increased mortality, and decreased growth.
5,000 to 6,999	Water not suitable for any class of poultry. Will almost always cause some type of problem, especially at the upper limits, where decreased growth and production or increased mortality probably will occur.
7,000 to 10,000	Water unfit for poultry but may be suitable for other livestock.
More than 10,000	Water should not be used for any livestock or poultry.

Source: Nutrients and Toxic Substances in Water for Livestock and Poultry, National Academy of Sciences, Washington, DC. **National Research Council (1974)**.

7.5 DRINKING SYSTEM CLEANOUT BETWEEN FLOCKS

- Drain drinking system and header tanks.
- Determine the capacity of the drinking system.
- Prepare the cleaning solution to the manufacturer's recommendation.
- Where possible, remove header tank and scrub it clean.
- Introduce the solution into the water system, usually in the header tank.
- Make sure protective clothing and eyewear are worn when using chemicals.
- Turn on the tap at the end of the drinking line and let the water run through until the sanitizing solution appears, then close the end tap.
- Raise each drinker line.
- Allow the solution to circulate through the drinking system.
- If circulation is not possible, let the sanitizing solution stand for at least 12 hours.
- After draining the system, flush the system thoroughly to remove bio-film and sanitizing chemical.

7.6 WATER TESTING

Water testing should be performed on a periodic basis but at least yearly. Samples should be collected at both the well house and at the end of a drinker line using a sterile container and analyzed at an accredited lab. When taking the water sample, it is important not to contaminate the water sample.

Water Quality Standards for Poultry

Contaminant, mineral or ion	Level Considered Average	Maximum Acceptable Level
Bacteria Total bacteria	0 CFU/ml	100 CFU/ml
Coliform bacteria	0 CFU/ml	50 CFU/ml
Acidity and hardness pH	6.8-7.5	6.0-8.0
Total hardness	60-180 ppm	110 ppm
Naturally occurring elements Calcium (Ca)	60 mg/L	
Chloride (Cl)	14 mg/L	250 mg/L
Copper (Cu)	0.002 mg/L	0.6 mg/L
Iron (Fe)	0.2 mg/L	0.3 mg/L
Lead (Pb)	0	0.02 mg/L
Magnesium (Mg)	14 mg/L	125 mg/L
Nitrate	10 mg/L	25 mg/L
Sulfate	125 mg/L	250 mg/L
Zinc		1.5 mg/L
Sodium (Na)	32 mg/L	50 mg/L

Source: Muirhead, Sarah, Good, clean water is critical component of poultry production, Feedstuffs, 1995.

Water Sampling Technique:

1. Sterilize the end of the tap or nipple by using an open flame for 10 seconds. Never use a chemical for this process as it may affect the sample.
2. In the absence of an open flame, run the water for a few minutes before taking the sample.

The water supplied to the birds should be fit for human consumption.

8. NUTRITION MANAGEMENT

Broiler diets are formulated to provide the energy and nutrients essential for health and efficient broiler production. The basic nutritional components required by the birds are water, amino acids, energy, vitamins and minerals. These components must act in concert to assure correct skeletal growth and muscle deposition. Ingredient quality, feed form and hygiene directly affect the contribution of these basic nutrients. If raw ingredients or milling processes are compromised or there is an imbalance in the nutrient profile of the feed, performance can be decreased. Because broilers are grown to a wide range of end weights, body compositions and production strategies, it is impractical to present a single set of nutritional requirements. Therefore any expression of nutrient requirements should only be viewed as a set of guidelines from which to work. These guidelines must be adjusted as necessary to address specific scenarios from one producer to another.

Selection of the optimum diets should take into consideration these key factors:

- Raw material availability and cost.
- Separate sex growing.
- Live weights required by the market.
- The value of meat and carcass yield.
- Fat levels required by specific market needs such as oven-ready, cooked and further-processed products.
- Skin color.
- Meat texture and flavor.
- Feed mill capabilities.

Feed form varies greatly as diets may be prepared as a mash, crumble, pelleted or extruded product. Blending the manufactured feed with whole grains prior to feeding is also common in some areas of the world. Further processing of feed is often preferable as there are both nutritional and managerial benefits. Pelleted or extruded diets generally have a greater ease of handling when compared to mash feeds. Nutritionally, further-processed feeds show a noted improvement in flock efficiency and growth rates when compared with mash feeds.

Crude Protein:

The broiler requirement for crude protein actually describes the requirements for amino acids, the building blocks of protein. Proteins are found as structural components in tissues ranging from feathers to muscle.

Energy:

Energy is not a nutrient but a means to describe the metabolism of energy yielding nutrients. Energy is necessary for maintaining the bird's basic metabolic functions and body weight growth. Traditionally, the metabolizable energy system has been used to describe the energy content of poultry diets. Metabolizable energy (ME) describes the gross amount of energy of a feed consumed minus the gross amount of energy excreted.

Micronutrients:

Vitamins are routinely supplemented in most poultry feeds and can be classified into either water-soluble or fat-soluble. Water-soluble vitamins include the B-complex vitamins. Vitamins classified as fat-soluble include A, D, E and K. The fat-soluble vitamins can be stored in the liver and other parts of the body.

Minerals are inorganic nutrients and are classified as major or trace elements. The major minerals include calcium, phosphorus, potassium, sodium, chlorine, sulphur and magnesium. Trace minerals include iron, iodine, copper, manganese, zinc and selenium.

Feed Testing:

A systematic approach to feed sampling on the farm is a "best practice" policy. A good feed sampling technique is important if the results of the analysis are to reflect the real nutrient content of the feed. A sample must be representative of the feed from which it was taken. This cannot be achieved by "grabbing" a sample of feed from the trough or pan. In order to collect a representative feed sample it is necessary to take sub-samples and combine them into a composite sample. It is recommended that five sub-samples from each delivery of feed be taken. Sampling from the feed lines is not recommended as sifting of ingredients or fines will skew results. Samples should be stored in a refrigerator until the flock is processed. Each sample should be recorded with the date, feed type and delivery ticket number. If problems arise during production and feed is suspected, samples should be analyzed. Lab reports should be compared with nutrient specifications for the respective diets.

Phase Feeding:
Nutrient requirements generally decline with broiler age. From a classical standpoint, starter, grower and finisher diets are incorporated into the growing program of broilers. However, bird nutrient needs do not change abruptly on specific days, but rather they change continuously over time. Most companies feed multiple feeds in an attempt to match bird nutrient requirements. The greater the number of feeds a bird receives, the closer the producer can feed his birds to the requirement. The number of feeds is limited by economic and logistical factors, including feed mill capacity, transportation costs and farm resources.

Dietary nutrient concentrations are based on the objectives of the producer. There are three main objectives of feeding broilers and most producers use a combination of these.

Diet Type 1:
Nutrient-rich to optimize live weight gain and feed conversion. This approach may promote additional carcass lipid content and possibly metabolic disorders. In addition, diet cost will be high.

Diet Type 2:
Lowered energy content but optimal crude protein and amino acid content. This approach will result in less lipid gain but maximize lean mass production. Live weight and feed conversion will be negatively affected but cost per lean mass will be optimal.

Diet Type 3:
Low nutrient concentration. This approach will result in lower live weight growth and higher feed conversion but cost per live weight may be optimum.

Feed Withdrawal:
During this period, special attention should be directed towards medication and vaccine withdrawal dates to ensure there is no residue retained in the carcass at processing. Carefully kept records are essential in this determination.

Supplemental Whole Wheat Feeding:

The feeding of supplemental whole wheat to broiler chickens is being practiced in many countries around the world. Benefits observed include a reduction in feed cost and therefore cost per kg (lb) of live weight, improvements in gizzard development resulting in improved digestive efficiency and the ability to manipulate the nutrient intake on a daily basis if necessary. Possible disadvantages are reduced growth rate, reductions in lean gain and poorer uniformity if adjustments to the compound feed are not made.

Supplemental wheat may be added either at the feed mill or at the farm. While adding whole wheat at the farm is preferable due to the increased flexibility it offers, this requires an on-farm feed proportioning system as well as additional bulk bins. At the feed mill, whole wheat may be added in the mixer or during the loading of the feed truck. Adding the whole wheat at the feed mill also allows for the potential of some processing, if available, such as roller milling.

Typically beginning around day 7, or when birds weigh 160 g, supplemental whole wheat is added at a level of 1%-5%. This can be increased up to approximately 30% using gradual increases of 1%-5%. The maximum percent used will depend on the compound feed quality and nutrient density, wheat quality, desired performance and the performance of the individual flock.

It is important to take into account the dilution effect of adding supplemental whole wheat to the diet. Any medications will need to be adjusted as needed to ensure they are fed at the correct levels. Regular monitoring of bird live weight is important to determine the effect whole wheat addition has on a particular flock. The supplemental whole wheat should be removed 48 hours before slaughter to avoid contamination of the carcass during evisceration.

9. CATCHING PROCEDURES

LOGISTICS

The goal of the planning and coordination of the catching process is to insure low DOA [dead on arrival] , minimal shrink, and high animal welfare standards. If done properly this is a very complex process that will require the coordination of farm starting times, multiple catching crews and processing plant schedules. The benefits of good planning in terms of improved mortality shrink and plant yield are very real and make it worth the effort.

The catching process requires good communication and planning that must include the following key areas:

- Plant processing schedule - To insure that birds are available to slaughter with minimal holding time.
- Transportation and driving distance from farm to plant - Coordinate the transportation assets to maximize their utilization.
- Catching crew schedule - Ensure that crews are scheduled to catch the birds.
- Farm set up - Time frames to shut off and raise feeders and water.

FEED AND WATER WITHDRAWAL

The feed withdrawal and water withdrawal process is critical in optimizing feed conversion, plant yield, and preventing holding shrink and plant contamination. The purpose of feed withdrawal is to empty the digestive tract, preventing ingested feed and fecal material from contaminating the carcasses during the evisceration process.

Always allow access to water as long as possible prior to catching. Only raise the water after the catchers get to the house and start setting up. On multiple house farms only withdraw water just prior to commencing catching.

Optimum recommended time off feed is a window of 8 hours to 12 hours. Less than 8 hours will result in excess feed and fecal residues in the digestive tract. This is a waste of the undigested feed as there will be no conversion to meat .The excess feed residue will cause yield and processing problems in the plant. Fecal residues cause contamination of plant equipment. Feed withdrawal in excess of 12 hours causes the intestines to lose their tensile strength, making them easy to tear and rupture. The intestinal contents will very viscous due to the start of intestinal cell necrosis. This condition will cause major equipment contamination in the plant and continue to get worse with time.

In a properly planned program the feeders should be raised in the broiler house so the first load from the house will be unloaded and started kill as close to the 8 hour mark as possible with the last load from the house being killed as close to being inside the 12 hour mark as possible. Remember the water must remain down to the start of catch.

Also in the planning process it should be considered that product held at the plant even in a good holding shed or holding area will continue to lose weight at a rate of .25% or more of body weight per hour from natural shrink. Part of the logistical planning should include minimizing this holding time.

It is important to refer to local legislation for feed withdrawal restrictions.

PREPARATION

Regardless of method of catch or type of containers used there are some common general operating procedues that should be followed.

- Birds should be carefully placed in clean crates or modules to a density that complies with manufacturer's recommendations. These densities should be reduced in summer months.
- Minimize light intensity reduce bird activity. Light in the house should be only enough to see to do the job. If dimming is not feasible, the use of blue or green lights will calm birds and reduce activity.
- When possible schedule catching at night to reduce bird activity.
- When catching during the day it is recommended to utilize curtains and other methods to keep the houses as dark as possible. In cases where light cannot be restricted migration fences and gates must be used to restrict bird crowding. Coops can be used with great effect by building pens from the coops to restrict bird movement. Calm birds facilitate better ventilation, reduce bird stress and diminish the risk of piling.
- Reduce as much as possible pre catch activity. Make sure all feeders and water are rolled up. Make sure any unnecessary equipment or items that might interfere are out of the house.
- Ensure ventilation is maintained.
- Make sure the proper number of head per coop or module compartment is communicated to the catching crew. This number is determined by container type,bird size and seasonal conditions.
- If there is time between loads, turn up the lights, replace the water and gently walk through the birds.

PREPARATION FOR CATCHING

Welfare considerations should be of utmost importance during catching. Special care should be given to minimize bruising and downgrades. The stockman should be present during the catching operation to ensure that the correct procedures are followed.

Possible causes of downgrades in the processing plant

Causes	Scratching	Bruising	Broken limbs	Blisters- hock/breast
Too high stocking density	•	•	•	•
Feeding system break down	•			
Incorrect lighting program	•			
High light intensity	•			
Aggressive movement by stockman	•	•	•	
Poor feathering	•			•
Aggressive catching	•	•	•	
Poor litter				•
Incorrect nutrition	•		•	•
Plucking machines			•	
Ventilation	•			•
Drinker management				•

Monitoring bruising color can give an indication of when it happened and how to cure the problem.

Color of bruise	Age of bruise
Red	2 minutes
Dark red and purple	12 hours
Light green and purple	36 hours
Yellow green and orange	48 hours
Yellow orange	72 hours
Slight yellow	96 hours
Black and blue	120 hours

MACHINE CATCHING

As with all technology, machine catching equipment is being improved every year.

Machine catching is a viable option to manual catching in areas where labor is not available or other factors make manual catching not an attractive option.

With machine catching it is important to implement a good preventative maintenance program. Maintenance and repair cost need to be considered when implementing a machine catching program.

MANUAL CATCHING

The two most common methods of manual catching are by the feet or by the back. With both machine & manual catching, crew training is essential to ensure correct bird handling with minimal damage.

The vast majority of companies catch by the feet. The following handling limits need to be enforced:

- Grip only the shank to limit drum bruising
- Handling limits - depends on bird size and crate/module design:
    - No more than 3 large birds per hand - >2.6 kg (5.75 lbs)
    - Smaller birds – up to 6 birds per hand
    - Limit handling birds more than once – do not pass birds between catchers.
    - Back catching is limited to 2 birds – common practice when coops are used. This limits wing damage.

10. BIO-SECURITY AND FARM SANITATION

10.1 BIO-SECURITY

Bio-security is the term used to describe an overall strategy or succession of measures employed to exclude infectious diseases from a production site. Maintaining an effective bio-security program, employing good hygiene practices and following a comprehensive vaccination program are all essential to disease prevention. A comprehensive bio-security program involves a sequence of planning, implementing and control. Remember, it is impossible to sterilize a house or the premises. The key is to reduce pathogens and prevent their reintroduction.

Outlined below are various key points to a successful bio-security program:

- Limit non-essential visitors to the farm. Keep a record of all visitors and their previous farm visits.
- Farm supervisors should visit the youngest flocks at the beginning of the day and working by age to the oldest flock for the last visit in that day.
- Avoid contact with noncompany poultry, particularly backyard poultry.
- If equipment must come from another farm, it should be thoroughly cleaned and disinfected before it comes onto the farm.
- Provide wheel dips or wheel spraying facilities at the farm entrance and allow only necessary vehicles on site.
- Farms should be fenced.
- Keep doors and gates locked at all times.
- Absolutely no other poultry should be kept on the same farm as your poultry unit. Farm animals other than poultry should be fenced separately and have a different entrance from the poultry farm enterprise.
- No pet animals should be allowed in or around the poultry housing.
- All farms should have a vermin control plan which includes frequent monitoring of rodent activity. Adequate supplies of rodent bait must be maintained.
- All houses should be vermin proof.
- The area around the poultry house should be free from vegetation, debris and unused equipment that could harbor vermin.
- Clean up feed spills as quickly as possible and fix any leaking feed bins or feed pipes.
- Farms should have toilet and hand washing facilities separate from the poultry house.
- A dedicated changing facility for protective clothing and footwear should be sited at the farm entrance.
- Provide hand-sanitizing facilities at the entrance to each house.
- Provide well-maintained footbaths at the entrance to each poultry house.
- Clean footwear before using footbath to remove organic material, which could inactivate the disinfectant.

- The choice of disinfectant for the footbath needs to be one that has a broad spectrum of activity and be fast acting because of limited contact time.
- Incorporate a boot-change or boot cover system at each entry to the poultry house.
- Single-age broiler farms are highly recommended to reduce the cycling of pathogens and/or vaccine agents within the farm.
- Birds should be placed from similar age parent flocks of the same vaccination status.
- Depletion of birds should be complete before arrival of new chicks.
- Catching crews should be provided with protective clothing. Equipment such as coops/crates and forklifts should be washed and disinfected before entry to the farm, especially if partial depopulation is practiced.
- Adequate down-time between flock placements is essential.
- If litter is re-used between flocks, all damp or caked litter should be removed and heat turned on in time to release any built up ammonia and to encourage drying of litter prior to placement of next batch of chicks; a minimum requirement of 48 hours is suggested.
- Drinking systems should be drained and flushed with an approved disinfectant before flock placement. Ensure that the system is again flushed with clean water before placement to remove any residue.
- Test water at least yearly for mineral levels and microbial quality.

10.2 FARM SANITATION

The single most important factor in keeping poultry healthy is maintaining good hygiene. Healthy parents and hygienic hatchery conditions contribute greatly to disease-free chicks. Good hygiene standards will reduce disease challenge.

Farm sanitation does not just mean the choice of the right disinfectant. The key to farm sanitation is effective cleaning. Disinfectants will be inactivated by organic material. The following points are the basic steps for effective farm sanitation. However, these steps are not applicable when litter is re-used.

Key points of a successful farm sanitation program:

- At the end of each flock remove all the birds from the farm.
- Apply an insecticide. This is best carried out immediately after depopulation and before the litter and building cool. Heavy insect infestations may require an additional insecticide application after the disinfection process is complete.
- Maintain the rodent control program after depopulation.
- Remove all unused feed from the feed system, including all bins and augers.
- Carefully consider the health status of the depleted flock before moving the feed to another flock.
- Clean out all the litter from each house and remove it in covered vehicles.
- Clean all the dust and dirt from the building, paying special attention to less obvious places such as air inlets, fan boxes and the tops of walls and beams.
- Dry clean any equipment that can not be washed directly and cover it completely to protect it from the washing process.

- Open up any drainage holes and water runoff pathways and wash down all interior surfaces of the house and fixed equipment with a general detergent through a pressure washer. If using a foam or gel, allow the recommended soak time to allow the product adequate time to work. The process should be carried out in a predetermined fashion, washing from the top to the bottom of the house (ceiling to the floor). If the fans are in the roof they should be washed before the ceiling.
- In curtain sided houses, special attention should be given to cleaning both the inside and outside of the curtain.
- The house should be washed from one end to the other (paying special attention to fans and air inlets) and washed to the end with the best drainage. There should be no standing water around the poultry house and each farm should have adequate drainage that meets local legal requirements.
- House control rooms should be carefully cleaned as water may damage electricity control systems. Power air blowers, vacuums and wiping with a damp cloth (where possible and with safety in mind), may be helpful in such areas.
- If a water storage or header tank is present, where possible open it and scrub it clean with a detergent.
- Drain the drinking system and header tank completely before adding cleaning solution.
- It is best, if possible, to circulate the sanitizing solution in your drinking system. If not, leave it to stand in the drinking system for a minimum of 12 hours before completely flushing the system with clean water.

- Removed equipment should be cleaned first with a detergent (or, if needed, a scale remover) and then thoroughly disinfected.
- Any equipment or materials such as a fiber chick guard or feeder lids that cannot be cleaned should not be reused for the next crop and should be safely destroyed.
- External areas such as gutters, fan boxes, roofs, pathways and concrete areas should be cleaned and maintained. Remove any washed out litter or organic matter from the farm compound. Unused and unneeded equipment should be removed from the farm.
- Carry out any equipment or facility repairs at this point and re-plug/fill any drainage holes opened up prior to washing.
- Outside concrete areas and ends of the house should be washed completely.
- Drying down after washing is advantageous. Heat and/or fans can be used to aid in the speed of this process.
- Staff areas, canteens, changing areas and offices should also be thoroughly cleaned. All footwear and clothing should be given a complete washing and disinfection at this point.
- Apply an effective broad-spectrum disinfectant through a pressure washer with a fan jet nozzle. Thoroughly soak all the interior surfaces and equipment working from top to bottom. Fan boxes, inlets, support beams and posts require special attention.
- After disinfection, bio-security controls at house entrances must be reinstated.
- Adequate downtime between flocks will increase the effectiveness of the hygiene program.

To monitor the effectiveness of the sanitation program, a visual inspection and microbial culture are suggested. The effectiveness of the sanitation program can be measured using quantitative laboratory tests. Sterilization of the facilities is not realistic but microbiological monitoring can confirm that non-desired organisms such as salmonella have been eliminated. A documented audit including microbiological monitoring and attention to the performance of subsequent flocks can help to determine the effectiveness and value of the sanitation program.

11. BIRD HEALTH

Prevention is by far the most economical and best method of disease control. Prevention is best achieved by the implementation of an effective bio-security program in conjunction with appropriate vaccination. However, diseases can overcome these precautions and when they do, it is important to obtain advice from a veterinary professional. Caretakers and service personnel should be trained to recognize problems that may be attributed to disease. These include water and feed consumption patterns, litter conditions, excessive mortality, bird activity and behavior. Prompt action to address the problem is essential.

11.1 VACCINATION

Parent stock breeders are vaccinated for a number of diseases to effectively pass on maternal antibodies to broiler chicks. These antibodies serve to protect the chicks during the early portion of the grow out period. However, these antibodies do not protect the broilers throughout the entire grow-out period. Therefore, it may be necessary to vaccinate the broilers either in the hatchery or in the field to prevent certain diseases. The timing of vaccinations should be based upon the level of expected maternal antibody, the disease in question and current field challenges.

The success of a broiler vaccination program is contingent upon properly administering the vaccine. The following are important guidelines to consider when vaccinating by either water or spray. Specific recommendations for vaccine applications should be obtained from vaccine suppliers, as these supplier recommendations may be different from the following general guidelines.

A. WATER VACCINATION GUIDELINES:

- Flocks should ingest all vaccine within 1-2 hours of administration.
- Ensure that the vaccine is stored at the manufacturer's recommended temperature.
- Vaccinate early in the morning to reduce stress, especially in times of warm weather.
- Avoid using water rich in metallic ions (e.g. iron and copper). Bring in outside water of better quality if these conditions are known to exist.
- Water pH should be 5.5-7.5. High pH water can taste bitter to the birds and so reduce water and vaccine intake.
- Ensure rapid uptake of vaccine by depriving the birds of water a maximum of 1 hour before administration of vaccine begins.
- Prepare vaccine and stabilizer mixture in clean containers free of any chemicals, disinfectants, cleaners or organic materials.
- Use of a vaccine manufacturer's approved dye or colored stabilizer may help in determining when water lines are primed and how many birds have consumed vaccine.
- Turn off chlorinator 72 hours before administering the vaccine.
- Clean water filters 72 hours before vaccination commences to remove any detergent residues. Clean filters using plain water.
- Turn ultra-violet light off, if used, as this may inactivate the vaccine.
- Vaccination can be performed unevenly if done through a medicator.

- Calculate the needed amount of water by using 30% of the previous day's total consumed water. If no water meter is available, use the following calculation: Number of birds in thousands multiplied by their age in days multiplied by two. This equals the amount of water in liters needed to vaccinate over a 2-hour period.
- Mix 2.5 g (2 teaspoons) of powdered skimmed milk per liter (1.05 quarts) of water. Alternatively, commercial stabilizers can be used per manufacturer's recommendations.
- Prepare skimmed milk solution 20 min. before administering the vaccine to ensure the skimmed milk powder has neutralized any chlorine present in the water.
- Record vaccine product type, serial number and expiration date on pen charts or some other permanent flock record.
- Open each vial of vaccine while submerged under the water-stabilizer mixture.
- Rinse each vial of vaccine completely.
- Raise drinker lines.
- Pour the prepared vaccine, stabilizer and color solution into the header tank or storage tank.
- Prime the lines until the stabilizer or dyed water comes through the far ends of the lines.
- Lower drinker lines and allow birds to consume vaccine, making sure to turn water back on into the header tank just before the tank runs dry.
- Walk through the birds gently to encourage drinking and uniformity of application.
- Note the vaccine consumption time in the records and any adjustments needed for next application of similar age birds and equipment to reach the ideal time of 1-2 hours.

B. OPEN - BELL DRINKER SYSTEM:

- Two people are needed to carry out the vaccination procedure. One person is needed to mix the vaccine solution and the other person is needed to administer the vaccine.
- Clean each drinker, emptying it of water and litter. Do not use a disinfectant to clean the drinkers.
- Carefully fill each drinker in a predetermined fashion, making sure not to over fill the drinker or spill the mixed vaccine solution.

Monitoring water vaccination intake:

- Start to monitor after birds receive vaccine.
- Select 100 birds per house and check how many have dyed tongues, beak or crops.
- Divide the house into four parts and check for staining from 25 birds per house division.
- Calculate number of birds on a percentage basis with staining.
- Vaccination is considered successful when 95% of birds show staining.

Percentage of birds with Blue staining	Hour after administration of vaccine
75%	1 hour
95%	2 hours

If anything happens out of the ordinary during or after vaccination, closely monitor birds and consult your veterinary advisor.

Aerosol/coarse spray vaccination guidelines:

- Spray vaccination requires careful management. Spray may be lost through evaporation, settlement and drift before it reaches the birds.
- Vaccination equipment should be serviced as per manufacturer's recommendations to ensure correct functioning and dispersion of the correct particle size.
- Spray vaccinating day-old chicks in boxes at the farm requires a specific type of sprayer. (Consult vaccine manufacturer.)
- Check that the vaccination equipment is working properly at least 1 week before vaccination to allow time for repairs if needed.
- Operators inexperienced with specific house conditions and equipment should practice using plain water to verify walking pace.
- Use the sprayer for vaccination only. Never put disinfectant or any chemicals such as insecticides into your sprayer.
- Vaccinate early morning to reduce stress, especially in times of warm weather.
- Ensure that the vaccine has been stored within the manufacturer's recommended temperature range prior to usage (2-8 ºC / 36-46 ºF).
- Record vaccine product type, serial number and expiration date on pen charts or some other permanent flock record.
- Prepare vaccine and stabilizer mixture on a clean surface in clean containers free of any chemicals, disinfectants, cleaners or organic materials. (Use stabilizer only if called for by manufacturer of equipment and vaccine for this application method).
- Use fresh, cool distilled water.
- Open each vial of vaccine while submerged under the water.
- Rinse each vial of vaccine completely.
- Rinse the sprayer with distilled water and dispense a small volume through the unit just before adding the diluted vaccine.
- A typical coarse spray water volume is 15-30 L (4-8 gal) per 30,000 birds. (Again refer to vaccine and equipment manufacturer for specific volumes.)
- Turn the fans off before spraying commences and dim the lights to reduce stress on the birds and to allow easy movement through the house for the vaccinator.
- Pen the birds along the outside of the house for coarse water spraying. The distance between the vaccinator and the side wall must not be more than four meters (13 ft.).
- Coarse spray should be about 1 m (3 ft.) above bird height.
- Angle the sprayer nozzle down.
- Walk through the birds gently and carefully.
- Leave the fan off for 20 minutes after spraying has finished, provided that the birds are not being heat stressed and that they are not unattended.
- After vaccination, rinse the sprayer with distilled water and allow it to dry in a clean, dust-free environment. Take correct care of this valuable equipment.

12. RECORD KEEPING

Accurate record keeping is essential to monitor the performance and profitability of a flock, and to enable forecasting, programming and cash flow projections to be made. It also serves to provide an early warning of potential problems. The daily records should be on display for each house. In some countries the following data must be made available to the relevant authorities before the birds are slaughtered.

Daily Records include:

- Mortality and culls by house and sex
- Daily feed consumption
- Daily water consumption
- Water to feed ratio
- Water treatments
- Minimum and maximum daily temperatures
- Minimum and maximum daily humidity
- Number of birds taken for processing
- Management changes
- Type of culls

Flock Records:

- Feed deliveries (Supplier/amount/type/date of consumption)
- Feed sample from each delivery
- Live weight (daily/weekly/daily gain)
- Medication (type/batch/amount/date of administration/date of withdrawal)
- Vaccination (type/batch/amount/date of administration)
- Lighting program
- Litter (type/date of delivery/amount delivered/visual inspection)
- Chick delivery (number/date/time/count in boxes/truck temperature and humidity)
- Stocking density
- Chick Source (hatchery/breed/donor breeder code/chick weight)
- Weights of each load at processing plant
- Downgrades
- Date and time feed withdrawn
- Date and time catching started and finished
- Cleanout (total bacterial counts/visual inspection)
- Postmortem results
- Repairs and maintenance
- Generator tests weekly
- Alarm tests weekly
- Controlling sensors and thermostats (date calibrated)
- Technical visits

Annual Records:

- Water (tested at source and at the drinker)

13. APPENDICES

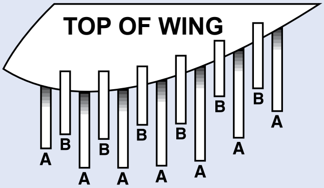
Metric Conversions:

Length:	
1 meter (m)	3.281 feet (ft.)
1 centimeter (cm)	0.394 inches (in.)
Area:	
1 sq. meter (m^2)	10.76 sq. ft. (ft^2)
1 sq. centimeter (cm^2)	0.155 sq. in. (in^2)
Volume:	
1 liter (L)	0.22 imperial gallon (IG)
1 liter (L)	0.262 US gallon (gal)
1 cubic meter (m^3)	35.31 cubic ft. (ft^3)
Weight:	
1 kilogram (kg)	2.205 pounds (lb.)
1 gram (g)	0.035 ounces (oz.)
Energy:	
1 calorie (cal)	4.184 joules (J)
1 joule (J)	0.735 foot pound
1 joule (J)	0.00095 British thermal unit (BTU)
1 British thermal unit (BTU)	252 calories (cal)
1 British thermal unit (BTU)	0.3 watt per hour (kWh)
Pressure:	
1 bar	14.504 pounds per square inch (psi)
1 bar	100,000 Pascals
1 Pascal (Pa)	0.000145 psi
Volume Flow Rate:	
1 cubic meter per hour (m^3/hour)	0.5886 cubic feet per minute (ft^3/min)
Stocking density:	
1 square foot per bird (ft^2/bird)	10.76 birds per square meter (birds/m^2)
1 kilogram per square meter (kg/m^2)	0.205 pounds per square foot (lbs/ft^2)
Temperature:	
Celsius to Fahrenheit	(°Celsius x 9/5) + 32
Fahrenheit to Celsius	(°Fahrenheit - 32) x 5/9
Light:	
1 foot-candle (fc)	10.76 lux
1 lux	0.0929 foot-candle

Feather Sexing Broiler Chicks

Broiler chicks in the feather sexable, slow feather format, can be feather sexed at day old as illustrated below.

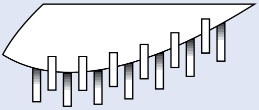
In the non-feather sexable, fast feather format, both males and females will show the same pattern of feather development illustrated by the diagram below relating to females.



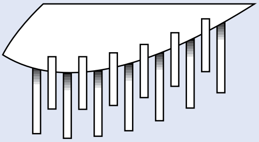
A-Primaries
B-Coverts

FEMALES
Coverts always shorter than primaries

At hatching all feathers short but coverts extend only ½ to ¾ length of primaries

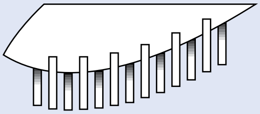


After several hours feathers longer but coverts still ½ to ¾ length of primaries

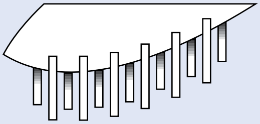


MALES
Coverts always as long as or longer than primaries

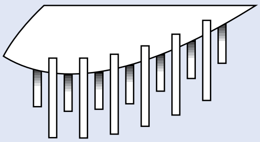
Coverts and primaries extend same length



Coverts extend slightly beyond primaries



Coverts extend greatly beyond primaries



1. Spread wing out like a fan.
2. Look at feathers on outer joint - bottom row of feathers are primaries, top row of feathers are coverts.
3. When the bottom row (primaries) of feathers is longer than the top row (coverts), the chick is female.
4. When the bottom row (primaries) of feathers is the same length, or shorter than the top row (coverts), the chick is male.

14. NOTES

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