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A Guide to Managing Broilers in Open-Sided Housing

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Forward

Although the number of open-sided broiler houses is decreasing, rearing broilers in open-sided housing is still preferred by growers in many parts of the world due to the sparse availability of electricity, poor infrastructure, and low levels of initial investment.

Open-sided broiler houses are found in areas where daytime temperatures can be as high as 35±5°C (95±10°F) and 20±5°C (68±10°F) during the night, and where extreme diurnal variations in temperature can exist. Relative humidity ranges from 20% to 90% and seasonal effects such as monsoons or a cooler (winter) season may reduce temperatures to below 10°C (50°F).

The objective of this supplement is to provide best practice management tools and guidelines to optimize broiler performance in open-sided broiler houses with the purpose of maintaining flock health and welfare while achieving good flock performance both live and through processing.

This document is a supplement to, and should be used in conjunction with, the ***Broiler Management Handbook***.

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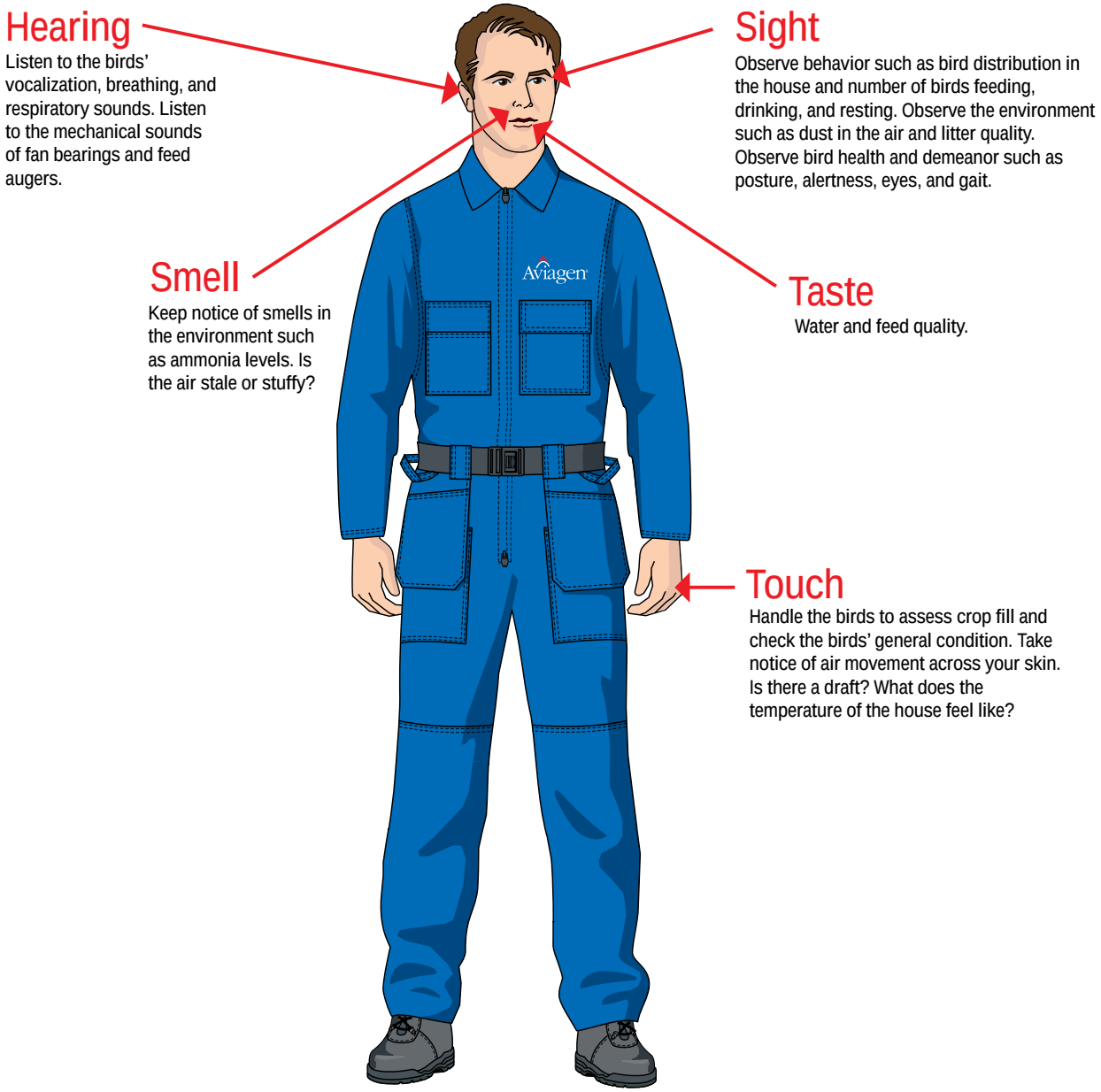
Stockmanship

The importance of stockmanship for broiler welfare, performance, and profitability must not be underestimated. A good stockman will be able to identify and respond to problems quickly.

The stockman must apply and interpret the best practice recommendations given in this guide and use them in combination with their own professional competence, practical knowledge, skills, and ability to meet the birds' needs.

Stockmanship is the result of the positive human interaction with the broiler and its environment (stock sense). The stockman must be constantly 'in tune' with and aware of the birds in the flock and their environment. To do this, the birds behavioral characteristics and the conditions within the poultry house must be closely observed. This monitoring is commonly referred to as 'stock sense' and is a continuous process that uses all the stockman's senses (**Figure 1**).

Figure 1: Stockmanship - using all the senses to monitor the flock.



Practical Stockmanship

If only farm records (growth, feed consumption, etc) are monitored, important signals from the birds and their environment will be missed. Using all the senses, the stockman must build-up an awareness of the environment, the birds' experience, and an understanding of what the normal behavioral characteristics of the flock are. This information should be continuously analyzed (in conjunction with the farm records) to allow any shortfalls in the birds' condition and/or environment to be rapidly identified and corrected.

The body-weight and FCR targets at a given age are usually the same across flocks, but each individual flock will have slightly differing management requirements to achieve those targets. To understand the individual management requirements of a flock and to be able to respond to each flock appropriately, the stockman must know and also sense what is normal for the flock.

The flock environment and behavior should be observed at various times of the day by the same person. This observation should be done at any time day-to-day management activities are completed in the house, but importantly, some specific inspections just to monitor flock behavior should be also made.

Before entering the house, be aware of the time and ambient climatic conditions. This will help to anticipate how any fans and heaters should be operating and if curtains are adjusted appropriately for the time of day, age of flock, and external environment.

Upon entry to the house, gently knock on and gradually open the door. As you enter the house ask yourself the following question.

Does the door into the house open with a slight resistance?
This will indicate the air pressure within the house and reflects the ventilation setting, i.e. inlet openings, fan operation.

Slowly enter the house and stop until the birds become accustomed to your presence. During this time, continuously use all your senses to assess the flock condition, ***LOOK, LISTEN, SMELL, AND FEEL***.

LOOK AT:

- **Bird distribution over the floor area.** Are specific areas being avoided suggesting an environmental issue (draft, cold, light)?
- **Bird respiration**. Are the birds panting? Is the panting specific to one area of the house suggesting an airflow or temperature issue?
- **Bird behavior - feeding, drinking, and resting.** Normally, broilers will be evenly split between these behaviors.
- **Number of circulation fans running, curtain position, are the heaters working?** Are the brooders coming on and off as expected. Are the circulation fans running to ensure adequate air movement over the birds or to help create a uniform heat distribution within the house, i.e. do the set points need adjustment?
- **Litter condition.** Are areas capping due to leaking drinkers or poorly maintained fogging nozzles? Is cold air entering the house and falling to the floor?
- **Feeders and drinkers.** Are they the right height, is there feed in the feeders, are the drinkers leaking? What is feed quality like?

LISTEN TO:

- **The birds.** Are the birds snicking/sneezing or making respiratory noise changes? What are their vocalizations like? Often this is best done in the evening when ventilation noise, etc., is reduced. How do the birds sound compared to previous visits, is it a vaccination response, is it related to a dusty, poor environment?
- **The feeders.** Have tube feeders been filled? Are the mechanical augers constantly running? Has the feed bridged in the feed bin?
- **The circulation fans.** Are the fan bearings noisy? Do fan belts sound loose? Routine maintenance can prevent environmental issues related to suboptimal air quality.

FEEL:

- **The air.** How does the air feel on your face? Stuffy (humid), cold, hot, fast air speed, no air speed? These either in combination or solely can indicate specific environmental issues such as not enough minimum ventilation.
- **The feed physical quality.** Is the crumb very dusty, do the pellets break down very easily in the hand and in the feeder?
- **The litter condition.** Pick up and feel the condition. If the litter stays together after compressing (does not spring apart) it indicates excessive moisture and this may suggest ventilation inadequacies.

SMELL:

- **The feed.** What does the feed smell like? Does it smell fresh or musty?
- **The environment.** What does the environment smell like, can you smell ammonia?

After the initial entry into the house and observation of the flock and the environment, slowly walk the entire house, assessing the points above. Walking the entire house is important to ensure that there is minimal variation in the environment and the bird behavior throughout the house, and not just in the area you are standing. As you walk through the house, get down to bird level. Pick up any birds that do not move away from you. Are they sick? How many birds are affected? Assess the way the flock moves in front of and behind you. Do the birds move back to fill the space you have created by walking through?

Periodically stop to handle and assess individual birds for the following:

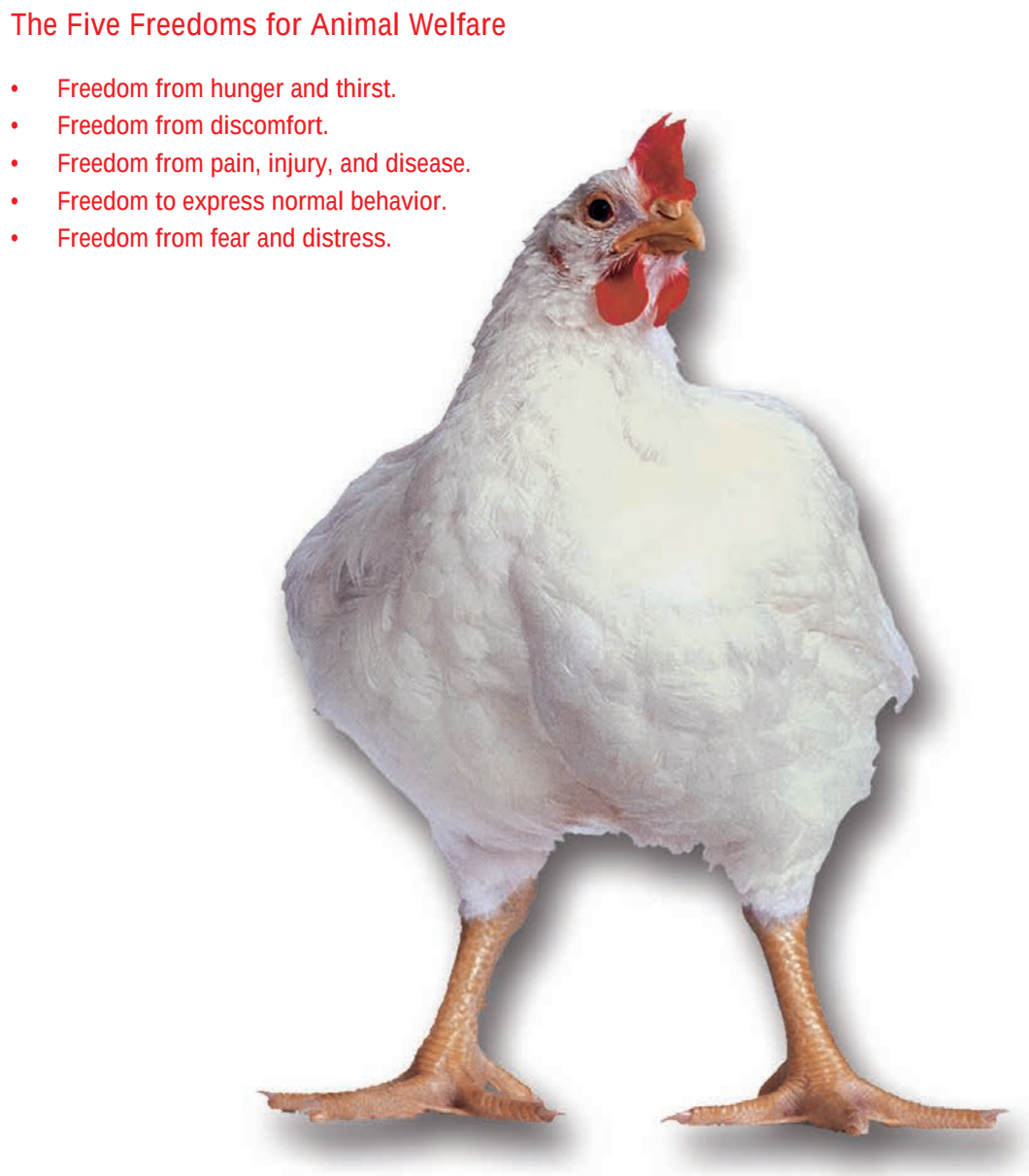
- **Eyes** should be clear, no signs of irritation.
- **Skin** should be unblemished with no scratches or hockburn marks.
- **Breast** should be unblemished with no blisters.
- **Feathering** should be clean with no feathers sticking out.
- **Leg health.** What is the gait of the birds?
- **Feet and hocks** should be clean with no irritation markings.
- **Vent** should be clean with no signs of loose droppings.
- **Beak and tongue** should have no nasal discharge (or feed sticking to beak), and no signs of tongue discoloration.
- **Crop.** Are they feeding? Does the crop contain litter? Is the crop very hard or soft? This will indicate the water availability.
- **General demeanor and alertness.**

These observations will help build a picture for each individual flock/house. Remember, no two flocks or houses are the same!

Compare this ‘stock sense’ information with actual farm records. Are the birds on target? If there are any irregularities they must be investigated and an action plan should be developed to address any issues that occur.

Stock sense, combined with the stockman's knowledge, experience, and skills in husbandry will produce a rounded technician who will also have personal qualities such as patience, dedication, and empathy when working with the birds. Good stockmanship will not only ensure that all birds are subject to the "Five Freedoms for Animal Welfare" (**Figure 2**), it will ensure efficiency and profitability.

Figure 2: The five freedoms for animal welfare.



Section 1 - Chick Management

House Preparation

Brooding Set-Up

Poor brooding techniques will adversely affect mortality rates, restrict feeding and drinking behavior, and increase susceptibility to diseases.

- The brooding area should be surrounded by clean canvas or plastic sheets for heat preservation. Tent brooding techniques will help to retain heat from the brooders while providing protection from cooler outside air which may chill chicks.
- Preheat the brooding area to stabilize the temperature for at least 24 hours prior to chick arrival (depending on heater type and capacity and season).
- The number of chicks per brooder ring should be based on the brooder heating capacity and type (see **Table 1**).
- Recommended environmental conditions at placement are:
  - « Air temperature: 30°C (86°F) at chick level in the brooding area.
  - « Floor temperature: 28-30°C (82-86°F).
  - « Slightly higher brooding temperatures (32-33°C / 90-91°F) and a longer period of preheating (48-72 hrs) may be required during periods of cold weather. Houses made of concrete will also benefit from an increased pre-heating time (a minimum of 48 hrs) and temperature (34-35°C / 93-95°F) during cold weather. The aim with concrete housing is to achieve an internal floor and wall surface temperature of 30-31°C (86-88°F) at placement.
  - « Temperature should be adjusted to account for chick activity and comfort once chicks are placed.
- For solid floor housing, litter should be spread directly and evenly on the floor to a depth of 5-10 cm (2-4 in).
- Slatted floors should be covered by a layer of plastic sheeting or netting with a layer of litter spread evenly to a depth of 3-5 cm (1-4 in) on top. In order to provide chicks with more room at the correct time, the whole slatted area should be covered in litter.
- Chicks should not have to travel more than 1 m (3.3 ft) for access to feed and water (**Figure 3**).

Figure 3: Correct brooding set-up with feed spread on 100% paper cover and one mini-drinker per 100 chicks. This is set-up for 800 chicks.

- Place feed initially on feeder trays and/ or paper covering 100% of the brooding ring area. If using feeder trays place one feeder tray for every 100 chicks.
- As a guide, approximately 40 g (1.5 oz) of feed per chick should be measured out and fed on paper / feeder trays prior to placement. At least 20-30% of the total feed offered to the chicks should be placed on the paper.
- Place one supplementary drinker for every 100 chicks (**Figure 4**).

Figure 4: Example of a supplementary drinker.

- Feeders and drinkers should not be placed directly under the heat source.
- For optimum tent brooding set-up, it is recommended to use a curtain that is 2-2.5 m (6.6-8.2 ft) high covering the whole brooding area (**Figure 5**).
- During daylight hours, the tent curtains should be partially lifted to improve air quality and movement to remove harmful gases and to help dry out the litter.
- The amount and height of curtain to be lifted-up in a brooding circle is dependent on the external environmental conditions (temperature, wind, rain, humidity, etc), chick behavior, and activity.

Figure 5: Example of tent brooding set-up.

Brooder Types

Table 1: Brooder types and their capacities.

Brooder Type	Recommended Number of Chicks / Brooder	Heat Output
Tin charcoal	250	
Gas brooder	750 (small) - 1000 (big)	17,000 to 225,000 British Thermal Units (BTU) per hr (5-65 kilowatt hrs) depending on size
Central heating or hot air blower	10,000	75,000 to 250,000 British Thermal Units per hr (22-73 kilowatt hrs) depending on size

Figure 6: Infrared gas brooder.

Advantages: Easy to use and practical. Different sizes available to cater for different brooding capacity.

Disadvantages: Regular inspection and cleaning is necessary to avoid incomplete combustion.

Figure 7: Charcoal brooder.

Advantages: Easily available and economical. Charcoal produces a stable heat output.

Disadvantages: Labor intensive. A large number of heaters are needed to provide a uniform heat distribution. Noxious gas build-up can be a problem (a pipe going up to and out of the roof is required to remove noxious gases.

Chick Placement

- Where possible, separate chicks into brooding groups according to supply flock or parent stock age.
- Place chicks immediately, gently and evenly onto paper within the brooding area.
- One to two hours after placement, a check should be made to ensure that all chicks have found feed and water and that environmental conditions are correct (**Figure 8**).
- Chicks must be evenly distributed throughout the brooding area. Behaviors should be more or less evenly split between eating, drinking, walking or resting.
- Adjustments should be made to environmental conditions based on chick behavior where necessary.

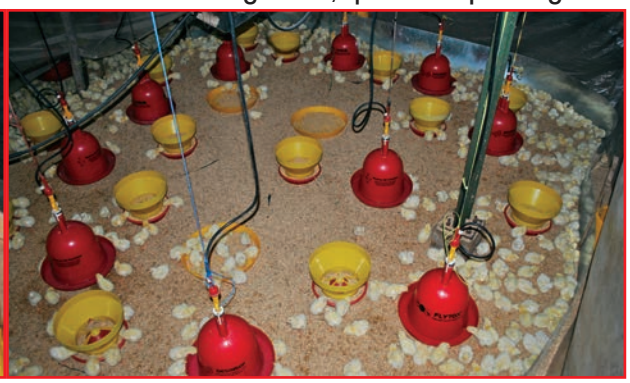
Figure 8: Chick behavior during brooding.

TEMPERATURE CORRECT

Chicks evenly spread and vocalizing contentedly

TEMPERATURE TOO HIGH

Chicks away from brooder, crowded near house or brooder ring walls, quiet and panting



TEMPERATURE TOO COLD

Chicks grouped together under brooders

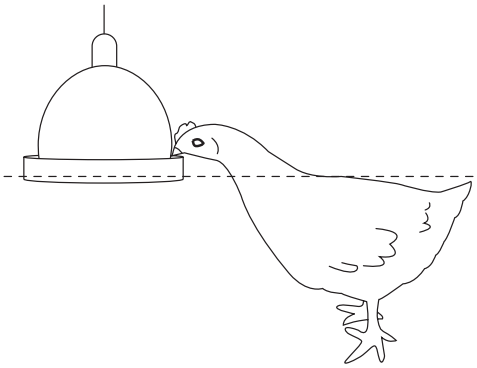
DRAFT

Chicks concentrated on one area

Drinker Management

- Under temperate climates water to feed ratio is around 1.7:1 (depending on drinker type). Water requirement will increase at higher ambient temperatures, increasing by approximately 6.5% per degree Celsius (2ºF) over 21ºC (70ºF). In tropical areas, prolonged high temperatures will double daily water consumption.
- Drinkers should be well maintained and a full system clean-cut should be completed between flocks.
- Chlorination of drinking water will help control bacteria counts. Chlorination to give between 3 and 5 ppm at drinker level is effective.
- Drinking water lines should be treated with an approved sanitizer on a routine basis (once per flock) to remove biofilm.
- Drinker height should be adjusted daily in line with bird height (**Figure 9**).

Figure 9: Correct drinker height (bell on the left and nipple on the right).



Feeder Management

- Chicks must be fed immediately upon arrival to ensure a good chick start.
- Feed should be placed on flat feeder trays (one per every 100 chicks) or on paper sheeting (covering 100% of the brooding area). If paper does not disintegrate naturally, it should be removed from the house from 3 days onwards (**Figure 10**).

Figure 10: Feeding management during brooding.

Example of a feeder tray | **Removal of paper at 3 days of age**

- The feeders/paper should never run out of feed.
- Feed on paper or in feeder trays should be topped-up regularly during the first 3-4 days. Frequent feeding in small volumes helps to stimulate chick activity and feed behavior.
- The transition from floor to automatic feeding should be managed carefully (see section on Post-Brooding Management).

Lighting During Brooding

- From day 1 to 7, provide chicks with 23 hours of light (30-40 lux) and one hour of darkness (0.4 lux / 0.04 fc). This will encourage early feed intakes.
- After 7 days of age a dark period of 4-6 hours should be provided. The provision of less than 4 hours of darkness will result in:
  - « Abnormal feeding and drinking behaviors.
  - « Sub-optimal biological performance.
  - « Reduced bird welfare.
- Light intensity must be uniformly distributed throughout the house.

Chick Start Assessment

- Check chick activity, crop fill (**Figure 11**), vent and foot temperature (**Figure 12**), and chick distribution 1-2 hours after placement.

Figure 11: Checking crop fill. The chick on the left has a full, rounded crop while the chick on the right has an empty crop.

- Checking crop fill at key times after placement (**Table 2**) is a good way of assessing appetite development and determining if all the chicks have found feed and water.

Table 2: Target crop fill assessment guidelines.

Time of Crop Fill After Placement	Target Crop Fill (% of Chicks with Full Crops)
2 hours	75
4 hours	80
8 hours	>80
12 hours	>85
24 hours	>95
48 hours	100

- A quick and easy way to check chick temperature is to pick chicks up and place their feet against your cheek. If the foot feels cold then this is an indication that the floor temperature may be lower than recommended or that brooding conditions are too cool for optimum bird comfort.
- Measuring chick vent temperatures gives a good indication of whether or not environmental temperatures at placement are correct. Vent temperatures should be between 39.4 and 40.5°C (103 and 105°F) for the first 4-5 days after hatch.

Figure 12: Checking vent temperature (left) and foot pad temperature (right).

- Monitor for the signs of dehydration by observing leg condition (**Figure 13**).

Figure 13: Leg of dehydrated chick.

KEY POINTS:

- Provide chicks with clean, biosecure housing.
- Tent brooding techniques will help retain heat from the brooders while protecting chicks from cool outside air.
- Preheat the house for at least 24 hours prior to chick arrival (depending on season and house type).
- Ideal environmental conditions at placement are:
  1. Air temperature: 30°C (86°F) at chick level in the brooding area.
  2. Floor temperature: 28-30°C (82-86°F).
- Spread litter evenly and to an appropriate depth for floor type.
- Ensure chicks have immediate and easy access to feed and water.
- Monitor chick behavior to determine if the environment is correct.
- Assess crop fill at key times after placement to check that all chicks have found feed and water.
- Monitor vent temperature to get an indication of whether or not brooding temperatures are correct.

Section 2 - Post-Brooding Management

Ideal Temperatures

Maintaining a consistent even temperature in open-sided houses is a challenge. Inconsistencies in environmental temperature (temperature fluctuations) cause the bird to constantly adjust and regulate its body temperature. This uses energy and has a negative impact on FCR. Bigger temperature fluctuations that cause the birds to sit and huddle to keep warm, or pant to cool down, will limit growth potential. The ideal temperature profile and how dry bulb temperature should vary with relative humidity to achieve the required temperature is given in **Table 3**.

Table 3: Dry bulb temperatures required to achieve equivalent temperatures at varying relative humidity (RH). Dry bulb temperatures, at the ideal RH at an age, are colored red.

Age (Days)	Dry Bulb Temperature at RH% °C (°F)				
	40	50	60	70	80
Day-old	36.0 (96.8)	33.2 (91.8)	30.8 (84.4)	29.2 (84.6)	27.0 (80.6)
3	33.7 (92.7)	31.2 (88.2)	28.9 (84.0)	27.3 (81.1)	26.0 (78.8)
6	32.5 (90.5)	29.9 (85.8)	27.7 (81.9)	26.0 (78.8)	24.0 (75.2)
9	31.3 (88.3)	28.6 (83.5)	26.7 (80.1)	25.0 (77.0)	23.0 (73.4)
12	30.2 (86.4)	27.8 (82.0)	25.7 (78.3)	24.0 (75.2)	23.0 (73.4)
15	29.0 (84.2)	26.8 (80.2)	24.8 (76.6)	23.0 (73.4)	22.0 (71.6)
18	27.7 (81.9)	25.5 (77.9)	23.6 (74.5)	21.9 (71.4)	21.0 (69.8)
21	26.9 (80.4)	24.7 (76.5)	22.7 (72.9)	21.3 (70.3)	20.0 (68.0)
24	25.7 (78.3)	23.5 (74.3)	21.7 (71.1)	20.2 (68.4)	19.0 (66.2)
27	24.8 (76.6)	22.7 (72.9)	20.7 (69.3)	19.3 (66.7)	18.0 (64.4)

**Temperature calculations based on a formula from Dr. Malcolm Mitchell (Scottish Agricultural College).*

Stocking Density

- The number of chicks to be placed in each house must be calculated according to floor area, age at processing, processing weight, and expected weather conditions. However, stocking density is also a decision based on economics and local welfare regulations.
- Overstocking increases the environmental pressures on the broiler, compromises bird welfare, and will reduce profitability.
- In open-sided houses, it is not recommended to grow birds to live weights above 3 kg (6.6 lb).
- In hot conditions, stocking density should be reduced depending on ambient temperature and humidity and in accordance with house type and equipment capabilities. For example:
  - « During hot weather, a maximum stocking density of 20-25 kg/m^2 (4-5 lb/ft^2) at processing should be implemented.
  - « At the hottest times of the year a maximum of 16-18 kg/m^2 (3.2-3.7 lb/ft^2) should be implemented.

Feeding in Hot Periods

- Feed birds during the coolest part of the day (before 11 am and after 4 pm).
- Providing good feed physical quality (crumble or pellets) will minimize the energy expended to physically eat and reduce the heat generated during feeding activity. Optimal feed form will also increase compensatory feed intake more efficiently during the cooler periods of the day or night.
- Crude protein must be balanced to avoid excess amino acids being deaminated and thus generating additional metabolic heat. For balanced protein recommendations, please refer to the current **Broiler Nutrient Specifications**.
- Vitamins E, D, A, C, and niacin are known to have a positive effect on the response of birds to the impact of heat. A general approach is to increase the level of vitamins by 1.25% per degree centigrade (2°F) as the temperature rises from 21 to 28°C (70 to 82°F). If the temperatures exceed 28°C (82°F), then further increases in vitamin levels should be made at the rate of 2.5% per degree centigrade (2°F). This guideline is dependent upon the vitamin levels used in the standard supplement. Supplementary vitamins should never be withdrawn from the diet.
- The addition of electrolytes, such as Sodium Bicarbonate and Potassium Chloride, have also been shown to reduce the impact of heat in broilers.
- Adequate, clean water supply must always be available and ventilation/air movement optimized (see section on ***Housing and Environment***).

Methods of Cooling Water Temperature in Hot Weather

- Flush drinker lines in hot weather to ensure that the water is as cool as possible.
- Insulate or shade pipes and water tanks from direct exposure to the sun.
- Position water tanks and piping underground or inside the house.
- Avoid the use of black water tanks.

Migration Fences

- Installing migration fences (**Figure 14**) at 30 meter intervals prior to 21 days of age will prevent bird migration across the house which may lead to hot spots and potential over-heating.
- Migration fences also make catching and partitioning or broiler selection according to size easier.
- Solid migration fences should be avoided as they will restrict airflow.

Figure 14: Migration fences**.**

Floor Space Expansion and Changes to Whole-House Feeding System

- It is important to expand the brooding area from 3 days of age onwards (**Table 4** and **Figure 15**). This will not only increase floor space but will also improve feeding and drinking space
- In hot climate open-sided houses, floor expansion (increasing the floor space during brooding) is important for minimizing the impact of heat.
- In houses with litter, the brooding area should be gradually increased so that by 10 to 12 days the chicks have access to the whole house area.

Table 4: Example floor expansion and stocking density changes with age.

Age	Birds/m^2 (birds/ft^2)
1 - 3 days	40-50 (3.7 – 4.6)
4 - 6 days	30-40 (2.8 – 3.7)
7 - 9 days	20-30 (1.9 – 2.8)
10 -12 days	15-20 (1.4 – 1.9)
13 days onwards	10-13 (0.9 – 1.2)

Figure 15: Floor expansion guide illustration.

DAY 1 - Brooding

DAY 3 - Floor Space Expansion

DAY 8 - Transition from tray feeders

DAY 10-12 - Full expansion on litter and shift to manual tube feeders/auto feeders

After transition to tube feeders, full slats and bell drinkers at 15-16 DAYS.

Transition to slats too early can cause leg damage. In slatted houses, transition to 100% slatted area should be completed around 12 to 15 days depending on weather conditions and bird growth (the birds feet should be able to fit on the slats comfortably). The age at which 100% slatted area should be given may need to be adapted according to individual flock needs.

KEY POINTS:

- Post-brooding temperature profiles should be reduced in accordance with bird behavior and comfort. They should be maintained as close as possible to recommended temperatures.
- It may be beneficial to reduce stocking densities in open-sided housing during the hotter times of the year to reduce the impacts of heat on the birds.
- During periods of hot weather birds should be fed during the coolest part of the day (before 11 am and after 4 pm) if possible.
- Drinker lines should be flushed on a regular basis to ensure water temperature does not become too hot.
- Floor space expansion should be started from day 3 onward and be completed with birds having access to the whole floor area by day 10-12 in litter houses and day 15-16 in slatted houses.
- During the floor space expansion period, birds should be allowed to transition from mini drinkers and feeder trays to bell or nipple drinkers and automatic feeders or tube feeders.
- Well-managed and well-maintained feeding systems are key for encouraging feed intake and promoting a good chick start.

House Design

There are two general designs for open-sided housing. Houses designed for broilers grown on litter (**Figure 16**) and houses designed for broilers grown on slats (**Figure 17**).

Figure 16: Example of a typical open-sided house for broilers grown on litter.

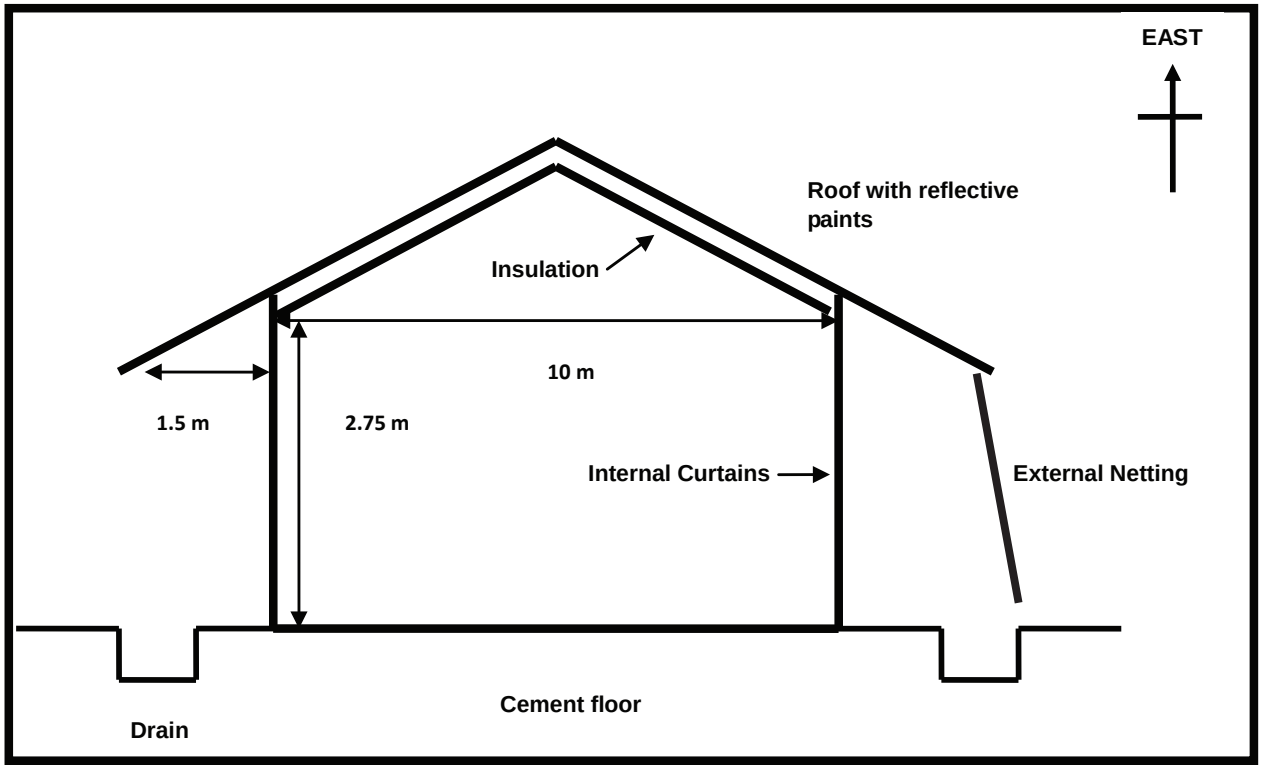
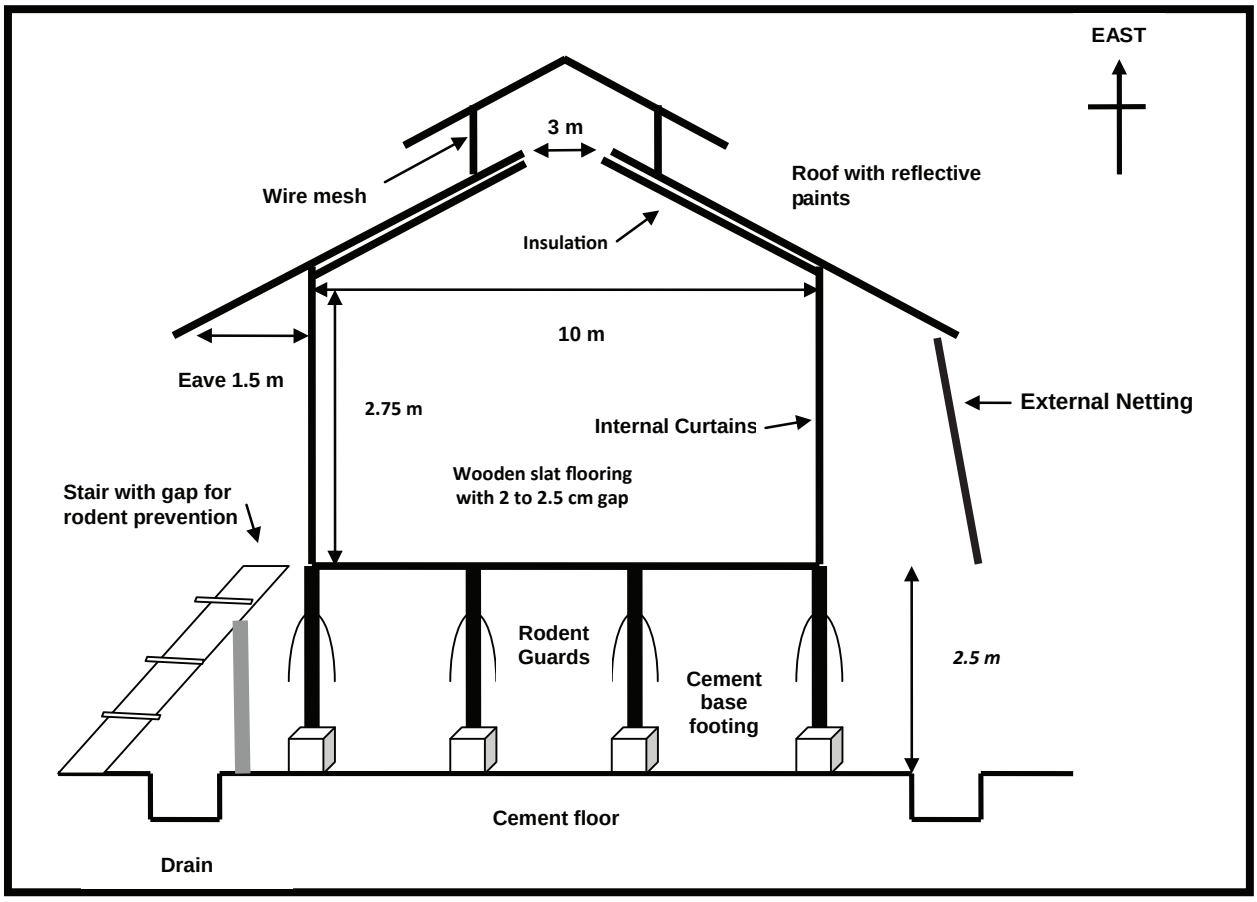


Figure 17: Example of a typical open-sided house for broilers grown on slats.



General house design layout recommendations (**Figure 18**) are as follows:

- The long axis of the house should be orientated in an east to west direction to avoid direct sunlight falling on to the sidewalls.
- Open-sided / naturally ventilated houses should always be built on higher ground rather than in valley locations as there is generally better air movement to assist in the correct ventilation of the house.
- To allow for optimum air exchange, house width should be no more than 10 m (33 ft).
- Distance between houses should be at least 12 m (39 ft) for improved biosecurity, better aeration / air exchange and to allow for safe movement of vehicles.

Figure 18: Good, general farm layout for open-sided houses. Picture on right shows good quality netting between houses for wild bird proofing and shade.

- Each house should have a store room for storage of feed and equipment. The store room must be covered with canvas at all times to protect the feed from direct sunlight and rain (**Figure 19**).

Figure 19: Example of a store room for feed and equipment covered by canvas for protection.

- A correctly installed drainage system should be in place to allow rainwater to flow away from the house as quickly as possible and help reduce humidity levels (**Figure 20**).

Figure 20: A correctly installed drainage system for an open-sided broiler house.

- It is important to have 2 water storage tanks inside each house; one for medication and the other for normal drinking water (**Figure 21**).

Figure 21: Example of 2 water tanks inside the house, one for medication and one for drinking water.

Roofing

Roof Design

- A double (**Figure 22**) or triple-ridge helps to direct heat quickly away from the house especially if no roof or ceiling insulation has been used in the roof design.

Figure 22: Example of a typical open-sided house with double-ridge roofing and a slatted floor.

- The higher the roof is above the birds, the better. A high roof will facilitate hot air exchange, increase air circulation and reduce the amount of hot air trapped at bird level.
- The angle of the roof should be 45 degrees. This reduces radiant heat accumulation and increases hot air escape from the house.
- Roof overhang / eaves should be at least 1.0 to 1.5 m (3.3 to 5.0 ft) depending on the height of the house and sidewall areas should also be covered with black netting to provide sun shade **Figure 23**. This will aid uniformity of internal light intensity and helps to prevent the birds migrating away from direct sunlight.

Figure 23: Extended roof overhang / eaves and sidewall net coverage to provide shade .

- All sidewalls and the double or triple ridge open areas should also be closed with wire mesh for wild bird proofing (**Figure 24**).

Figure 24: Example of black netting on the sidewalls of an open-sided house.

Roof Insulation

- A hot roof will increase house temperature. Under-roof insulation helps to shield the birds from excess heat radiation as it acts as a thermal barrier.
- Examples of under-roof insulation include:
  - « Dropped ceiling insulation.
  - « Polystyrene board insulation.
  - « Sprayed polyurethane.
  - « Reflective 'bubble' insulation (only effective for external temperatures of less than 30ºC / 86ºF).
- Reflective roofing:
  - « A shiny surface can reflect twice as much solar radiation as a dark surface.
  - « Roof reflectivity can be increased by cleaning and painting the surface with metallic zinc colored paint or by installing an aluminum roof.
  - « Roofs with a reflective surface should be maintained free from dust and rust.
  - « Annual painting and coating maintenance maybe required to prevent deterioration in reflectivity over time.
- A roof sprinkler system can be effective in cooling hot uninsulated roofing:
  - « Spray nozzles are placed at the apex of the roof. They operate intermittently during the hottest part of day only, to avoid wetting the ground and increasing environmental humidity around the house.
  - « This system does however use a large volume of water and may cause roof staining and corrosion.
  - « Roof sprinkler systems should only be used if there is an abundant supply of fresh clean water.
  - « Water should be filtered prior to use.

Deep Litter Housing

The use of litter can be of benefit for broiler leg and foot health. Choice of litter depends on the availability and economic viability of litter material. The advantages and disadvantage of some of the more common litter materials available for use in open-sided housing are given in **Table 5**.

Table 5: Advantages and disadvantages of some litter materials commonly used in open-sided broiler houses.

Litter Material	Advantages	Disadvantages
Pine Shavings and Sawdust	Preferred litter material in many areas.	Becoming expensive and limited in supply.
Hardwood Shavings and Sawdust	Often high in moisture.	Can become susceptible to dangerous mold growth if stored improperly.
Pine or Hardwood Chips	Used successfully in many areas.	May cause an increase in breast blisters if allowed to become too wet.
Pine or Hardwood Bark	Similar to chips and shavings in moisture holding capacity.	Medium-sized particles are preferred.
Rice Hulls	A good litter material where available at a competitive price.	Young chicks may be prone to litter eating.
Peanut Hulls	An inexpensive litter material in peanut producing areas.	Does have a tendency to cake and crust, but this is easily managed. Susceptible to mold growth and increased incidence of aspergillosis. Some problems with pesticides have been noted.
Coconut Husks	An inexpensive litter material in coconut producing areas.	Does have a tendency to cake and crust but this is easily managed.
Sand	Can be used in arid areas on concrete floors.	If too deep, bird movement may be impeded. Needs good management. More difficult to maintain floor temperature when brooding in cold weather. Need ample time and ventilation prior to brooding to ensure dryness.
Crushed Corn Cobs		Limited availability. May cause increased incidence of breast blisters.
Chopped Straw or Hay		High incidence of caking. Mold growth is also a possibility. Best used 50/50 with wood shavings. Slow to break down.

No matter what litter material is used, good litter should provide:

- Good moisture absorption.
- Biodegradability.
- Bird comfort.
- Low levels of dust.
- Freedom from contaminants.
- Consistent availability from a biosecure source.

More absorbent litter materials, such as wood shavings, should be spread evenly to a depth of 5-10 cm (2-4 in). Where floor temperatures are adequate at placement (a minimum of 28-30°C / 82-86°F) a litter depth of 5 cm (2 in) will be adequate. However, litter materials such as rice hulls, peanut hulls and coconut husks have lower moisture absorbency and therefore should be spread to a higher depth (8-10 cm / 3-4 in) at placement.

In open-sided housing it may be necessary to pay closer attention to litter management. Practices such as turning wet litter to allow it to dry out and replacing old or excessively wet litter may need to be done every 2-3 days in order to maintain good litter quality such as that shown in **Figure 25**. In deep litter houses good curtain management and adequate eave length are important to reduce the impact of heavy rainfall on litter quality.

Figure 25: Well-maintained dry litter in an open-sided broiler house.

Slatted-Floor Housing

Slatted housing can be a dryer and more hygienic housing option than deep litter as the manure drops through the space between slats away from the birds. Air movement from under the slats can also help cool older birds and reduce ammonia levels. The incidence of Coccidiosis challenge to a flock is also lower and there is no economic cost for litter material. Slatted floors are commonly made from wood or bamboo (**Figure 26**) and the height of the house floor from the ground outside should be approximately 2.5 m (8 ft) allowing for adequate air circulation and for ease of manure removal when needed. A fly repellent or insecticide must be applied to the manure, which collects under the slats. Manufacturer recommendations should be followed for application frequency and procedure.

Figure 26: Examples of slatted-floor housing.

Raised, open-sided slatted broiler house with wooden slats

Bamboo slats as seen from below

Bamboo slats covered with tarpaulin sheet and rice hulls during brooding period and up to 14-16 days of age

There are some important management points for slatted-floor houses which are particularly important for the first 14 days after chick placement:

- A net or plastic sheet must be placed over the slats at placement. This will prevent cool air from entering the house through the slats and chilling the chicks and will aid chick movement and encourage feeding and drinking activity. The sheeting/netting should be removed at 14-16 days of age.
- Slats should be maintained in good condition at all times. Any poor quality or broken slats should be replaced as soon as possible. Poorly maintained slats will lead to foot pad injury, impaired bird movement and reduced body-weight gain.

Vegetation

- Well-maintained and trimmed grass around a house can be cooler than bare ground, reflecting less solar heat into the house.
- Trees close to houses can provide shade from direct sunlight but they must be well pruned and be a minimum of 3 m (10 ft) away from the house.
- Fruit trees should not be planted as they will attract wild birds or other unwanted animals.
- To avoid any potential breaches of farm biosecurity, consult with a company veterinarian before planting any type of vegetation.

Ventilation

Ventilation management of open-sided broiler houses requires constant attention. Open-sided houses are vulnerable to high daytime temperatures and to outside colder air during the night or when raining. The challenge is to keep the chicks warm in the first 14 days of life and later, to provide appropriate ventilation by opening and closing sidewall curtains:

- When it gets warm, the curtains are opened to allow outside air into a house.
- When it gets cold, the curtains are closed to restrict direct exposure to cold air.

Natural ventilation can be either mechanically (circulation fans are used to help circulate and move air) or non-mechanically assisted.

Curtain Management

Ventilation in open-sided houses is provided by opening and closing curtains (or sometimes flaps) to allow/prevent convection currents (wind or breezes) to flow into the house. Curtains also:

- Reduce the amount of rainwater that may otherwise enter the house.
- Block and reflect sunlight.
- Keep warm air inside the house, especially during the middle of night or when raining.

Ideally, monitoring of both the ambient conditions (temperature, relative humidity, wind speed and wind direction) as well as the conditions within the house (temperature, relative humidity, air quality, and bird comfort) should occur.

Natural ventilation requires continuous management. Good curtain management is important in open-sided houses as the curtains are the only barrier between the birds and the outside environment.

- It is advisable to have a good curtain system that can be winched up and down.
- For young birds (from 3 to 5 days old) the top curtain should be opened by a maximum of 1 m (3.3 ft).
- The top curtain can be closed if it rains, to prevent water entering the house and reduce any windchill effects.
- The bottom curtain can be opened up for improved ventilation and air exchange during the hottest parts of the day from 2 weeks of age onwards.
- Top and bottom curtains should remain closed at night until 20-25 days of age depending on weather conditions.

Figure 27: Curtain management.

Curtain management (winding down in the middle of the day when weather is warm).	
Examples of curtains completely down / opened.	 
Example of a curtain completely up / closed.	
Double story open-sided house with curtains up during brooding.	
Top and bottom curtains can be used to **block sun light reflection from neighboring** roofs and protect younger birds from rain.	 
Example of a curtain completely up / closed.	

Circulation Fans

Circulation fans (**Figure 28**) are used in open-sided houses to increase air movement and improve air circulation over the birds. On warm or hot days with little wind or air movement outside, fans help to provide a windchill effect.

Figure 28: Example of circulation fans. A typical suspended circulation on the left and a typical floor standing fan on the right.

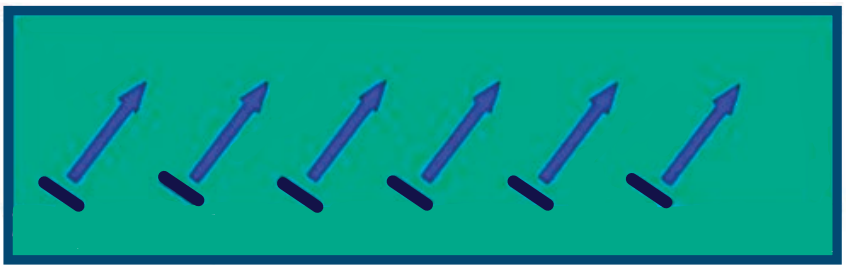
Circulation Fan Orientation

Fans should be orientated to blow down the long axis of the house (**Figure 29**) and should either be placed in the center of the house if using a single row or down each side of the house if using 2 rows. The first fan should be placed approximately 1.5 m (5 ft) from the gable end of the house and then fans should be placed at 10-12 m (33-39 ft) intervals down the length of the house. Fans should be staggered if 2 rows are used and should ideally be positioned so that the center of the fan is approximately 1.5 m (5 ft) from the floor.

Figure 29: Circulation fan orientation down the long axis of the house.

Fans may also be placed to blow diagonally across a house from the prevailing wind side (around 60 degrees from the sidewall – **Figure 30**). In this case, curtains should be fully open on both sides of the house when the fans are operating. Fans should not be placed too close to any objects or sidewalls as this may reduce efficiency.

Figure 30: Circulation fans placed to blow diagonally across the house.



Concrete Houses

It is important to remember that a lower, more solid roof type, such as those found on concrete houses, will trap heat closer to the birds. The use of smaller (45 cm / 18 in) circulation fans, placed close to the ceiling in two rows, every 10-12 m (33-39 ft) down the house will help remove this excess build up of heat when necessary and improve air circulation.

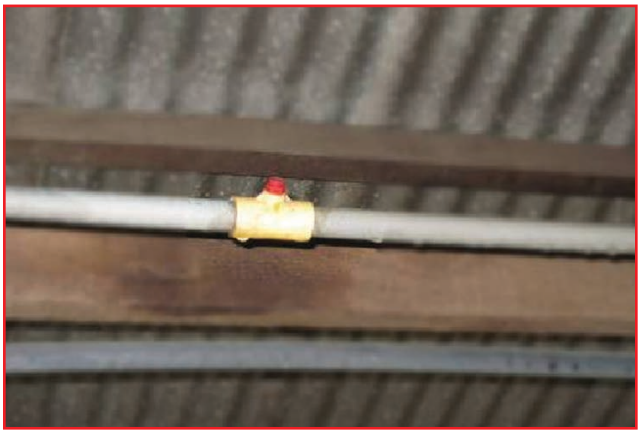
During hotter periods of the year and later grow-out, the use of 92 cm (36 in) fans placed with the center approximately 1.5 m (5 ft) from the floor and a quarter of the way from each end of the house, will help to increase wind chill across the birds. Curtains in this case should be opened approximately halfway on the prevailing wind side of the house and fully on the opposite side to ensure adequate windchill and air movement is achieved.

Fogging / Misting

Circulation fans can be used in conjunction with a fogging / misting system.

- Fogging systems (**Figure 31**) cool down air as it enters a house and so reduce the air temperature inside the house.
- Circulation fans should be used at the same time as the fogging system to help distribute the fine water droplets throughout the house and reduce the amount of water falling to the floor.

Figure 31: Example of a fogging system.



- There are 3 types of fogging system:
  1. Low pressure, 7-14 bar; droplet size up to 30 microns.
  2. High pressure, 28-41 bar; droplet size 10-15 microns.
  3. Ultra high pressure (misting), 48-69 bar; droplet size 5 microns.

- Low-pressure systems with larger particle sizes can cause wet litter if the house humidity is very high and air speed low.
- High-pressure systems will minimize residual moisture in the air generally aiding in litter management issues particularly in later growing periods.
- Nozzle pipes of fogging / misting systems should be 2 m (6.6 ft) in front of circulation fans so that droplets are dispersed evenly and do not fall directly on to the floor / birds.
- Foggers should be operated intermittently to avoid causing high humidity and also dampening litter / floor.
- Fogging and misting systems should not be used during times where relative humidity is particularly high (>80%) or air speed too low. At these times, only fans should be in use.

Lighting

Aviagen® does not recommend continuous lighting for the life of the broiler flock. Prior to 7 days of age, birds should be given 23 hours of light and 1 hour of darkness to encourage activity, and feeding and drinking behavior. A minimum of 4 hours of continuous darkness (light intensity of below 0.4 lux [0.04 fc]) should be provided at night after 7 days of age. Failure to provide at least 4 hours of darkness will result in:

- Abnormal feeding and drinking behavior.
- Sub-optimal biological performance.
- Reduced bird welfare.

In open-sided housing with little or no environmental control capability, the period without artificial light should be timed to maximize bird comfort. For example, feed can be removed for a time during the heat of the day and a period of lighting provided at night to allow birds to feed during this cooler period.

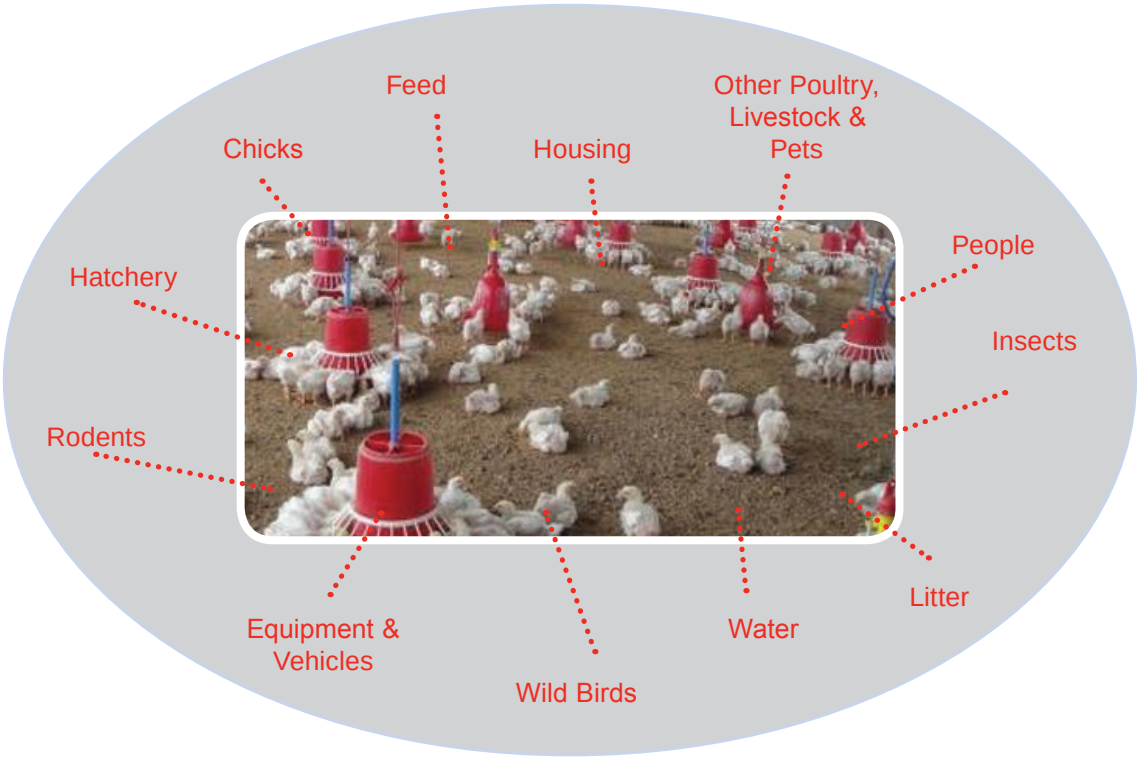
KEY POINTS:

- The long axis of a house should be orientated in an east to west direction to avoid direct sunlight falling on to the sidewalls.
- Houses should have an adequate roof overhang to improve shade and protect against heavy rain.
- A good in-ground drainage system should be installed around houses to carry rainwater away from the surrounding area as quickly as possible.
- A double or triple ridged roof helps to direct heat away from the house especially if no roof or ceiling insulation is in place.
- Curtain openings should be monitored and adjusted regularly to allow good convective airflow across the house and remove any built up heat. For younger birds they will also provide protection from the elements when needed.
- Circulation fans should be placed every 10-12 m (33-40 ft) down the house to increase air movement and improve air circulation over the birds.
- High pressure fogging or misting systems, may be used only in conjunction with circulation fans and when relative humidity levels are below 80%.

Biosecurity

Biosecurity is an integral part of any successful poultry production system. It refers to those measures taken to prevent or control the introduction and spread of infectious agents (viral, bacterial, or fungal) to a flock (**Figure 32**).

Figure 32: Potential routes of disease exposure.



Biosecurity requires:

- Control of human movement on to the farm.
- Control of rodents, insects and wild birds.
- Control of vehicular access to the farm.
- Control of equipment movement.
- Control of stock movement.
- Control of inputs to the flock such as feed and water.
- Efficient cleaning and sanitation/disinfection procedures.
- Use of a suitable vaccination/medication program.
- Use of a suitable routine sampling and testing program.

Cleaning and Disinfection

Site cleaning and disinfection is the start of good biosecurity. Site cleaning must remove all dirt, dust, debris and litter. Disinfection must remove all human and poultry pathogens and minimize the numbers of residual bacteria, viruses, parasites, and insects.

The procedure for cleaning and disinfection are as follows:

1. **Insect control:** As soon as the flock has been removed and while the house is still warm, the litter, equipment, and all surfaces should be sprayed with a locally recommended insecticide.
2. **Dust removal:** All dust, debris, and cobwebs must be removed from circulation fans, beams, and exposed areas of unrolled curtains, ledges, and stonework.
3. **Pre-spray:** With the curtains closed, spray a detergent solution throughout the inside of the house.
4. **Remove equipment:** Remove all the equipment that can be removed from the house. Raise automatic feeders and drinkers.
5. **Remove and dispose of litter/manure:** Litter must be disposed of as far away from the farm as possible (ideally a minimum of 3.2 km / 2 miles) and in accordance with local environmental regulations.
6. **Washing:** Spray detergent solution on all surfaces. Detergents must be used in accordance with manufacturer's instructions and must be compatible with the disinfectant that will be used to disinfect the house. Rinse the house and equipment with hot water and leave to dry. Following washing there should be no dirt, dust, litter, or debris left in the house. Staff facilities and equipment should also be cleaned at this time.
7. **Cleaning water and feed system:**

   The water system:

   - Drain pipes and header tanks.
   - Flush lines with clean water.
   - Scrub header tanks to remove scale and biofilm deposit and drain to the exterior of the house.
   - Refill tank with fresh water and add an approved water sanitizer.
   - Run the sanitizer solution through the drinker lines from the header tank ensuring there are no air locks. Make sure the sanitizer is approved for use with the drinker equipment and is used at the correct dilution.
   - Fill the header tank to normal operating level with additional sanitizer solution at appropriate strength. Replace lid.
   - Allow the sanitizer to remain for a minimum of 4 hours.
   - Drain and rinse with fresh water.
   - Refill with fresh water prior to chick arrival.

During a flock, biofilms will form inside water pipes which will decrease water flow and increase bacterial contamination. Between flocks, biofilms can be removed by using high levels (140 ppm) of chlorine or peroxygen compounds (chlorine dioxide applied at the appropriate level can also be used). These need to be flushed completely from the drinking system before birds drink. Treatment of the birds drinking water before use should be considered for water with a high mineral content. Where the water mineral content (especially calcium or iron) is high, cleaning may need to include acid scrubbing. However, acid scrubbing is less suitable for metal pipes as it can lead to corrosion.

Evaporative cooling and fogging systems should be sanitized using a disinfectant approved for use by the manufacturer.

The feed system:

- Empty, wash, and disinfect all feeding equipment, i.e. feed hoppers, track, chain, hanging feeders.
- Empty bulk bins and connecting pipes and brush out where possible. Clean out and seal all openings and fumigate wherever possible.

8. **Repairs and maintenance:** A clean and empty house provides the ideal opportunity for repairs and maintenance to be completed. In particular, repair or replace damaged walls, curtains and ceilings, carry out painting or white washing where required, check efficiency of fans, curtain functioning etc.
9. **Insecticide:** Prior to disinfection apply insecticide throughout the house and leave for 24 hrs.
10. **Disinfection:** Disinfection should not be carried out until the whole house (including all equipment) is thoroughly cleaned and dry. Approved disinfectants used according to the manufacturer's instructions will be most effective. Where selective coccidial treatments are required, compounds producing ammonia should be used by suitably trained staff.
11. **Floor treatments:** In some situations it may be necessary to use floor treatments as well (**Table 6**).

Table 6: Common floor treatments for poultry.

Compound	Application Rate		Purpose
	kg/m^2	lbs/100 ft^2	
Boric Acid	As Necessary	As Necessary	Kills Darkling beetles
Salt (NaCl)	0.25-0.50	5-10	Reduction of clostridium counts
Sulphur powder	0.01	2	Lowers pH
Lime (calcium oxide/ hydroxide)	As Necessary	As Necessary	Disinfection

12. **Vegetation:** The area within 3 m (10 ft) of the house must be free from vegetation and unused machinery and equipment and be well drained and free from standing water. Green areas surrounding the house should be cut regularly.
13. **Downtime:** Downtime is a key aid in reducing contamination between flocks. Downtime is an economic decision but the longer downtime between flocks the lower the risk of contamination. An ideal downtime between flocks is 15 days.

Evaluation of Farm Cleaning and Disinfection

The effectiveness of cleaning and disinfection must be routinely evaluated. This is commonly done by completing salmonella isolations (including the use of boot and dust swabs of the house). Total viable bacteria counts (TVC) may also be useful. Salmonella/TVC monitoring should be completed at least once a flock, after cleaning and disinfection. When cleaning and disinfection has been completed effectively, the sampling procedure should not isolate any Salmonella species.

Water Quality

- Unrestricted access to good quality water (no organic or suspended matter and free from pathogens) is essential.
- Ideal water temperature should be in the range of 18-21ºC (64-70ºF).
- After house cleaning and prior to chick delivery, water should be sampled for bacterial and mineral contamination at the source, the storage tank, and the drinker points. Any necessary corrective action should be taken prior to chick delivery. Chlorination to give between 3 and 5 ppm free chlorine at the drinker level is usually effective in controlling bacteria but this is dependent on the type of chlorine component used. Water pH should be kept between 5 and 7 (depending on type of chlorine used) in order for chlorine to be effective. If water pH is above 7.5 it may be necessary to add chlorine dioxide to reduce water pH and ensure chlorine effectiveness. Use of an approved sanitizer on a routine basis is also recommended. Measuring the oxidation reduction potential (ORP) of water is a good way of determining if the water sanitation program is working. An ideal ORP reading is between 700 and 800 mV.
- A total water quality test should be done at least once a year and more often if there are perceived water quality issues or performance problems.
- It is a good idea to routinely complete a visual check of the water supply during a flock. This is done by running a sample of water out of the end of each nipple line and making a visual check for clarity. If water lines and water sanitation are not adequate, there will be a high level of particulate matter in the water, visible to the eye. Action should be taken to rectify this issue.
- In hot weather, drinker lines should be flushed regularly to ensure water is as cool as possible.

Dead Bird Disposal

Dead birds should be removed from the shed daily. Any culling required for the purposes of bird welfare must be completed by trained and authorized personnel. All culling must be done complying to local legislation and in a humane and biosecure way at all times.

Appropriate methods of dead bird disposal and their advantages and disadvantages are given in **Table 7**.

Table 7: Methods of dead bird disposal.

Method	Advantages	Disadvantages
Disposal Pits	Inexpensive to dig and tend to produce a low odor	Can be a reservoir for diseases and require adequate drainage Ground water contamination is also a concern
Incineration	Does not contaminate ground water or produce cross contamination with other birds when facilities are properly maintained Little by-product to remove from the farm	Tends to be more expensive and may produce air pollution Must ensure that there is sufficient capacity for future farm needs Must ensure that carcasses are burned completely to white ash
Composting	Economical and if designed and managed properly, will not contaminate ground water or air	If not done to the correct temperature live viable diseases may be present on the farm.
Rendering	There is no on-farm disposal of dead birds Requires minimal capital investment Produces minimal environmental contamination Materials can be turned into feed ingredients for other appropriate livestock	Requires freezers to keep birds from decomposing during storage Requires intense biosecurity measures to ensure that personnel do not transfer diseases from the rendering plant to farm

Decreasing the Risk of Disease

Preventing Diseases Transmitted by Humans

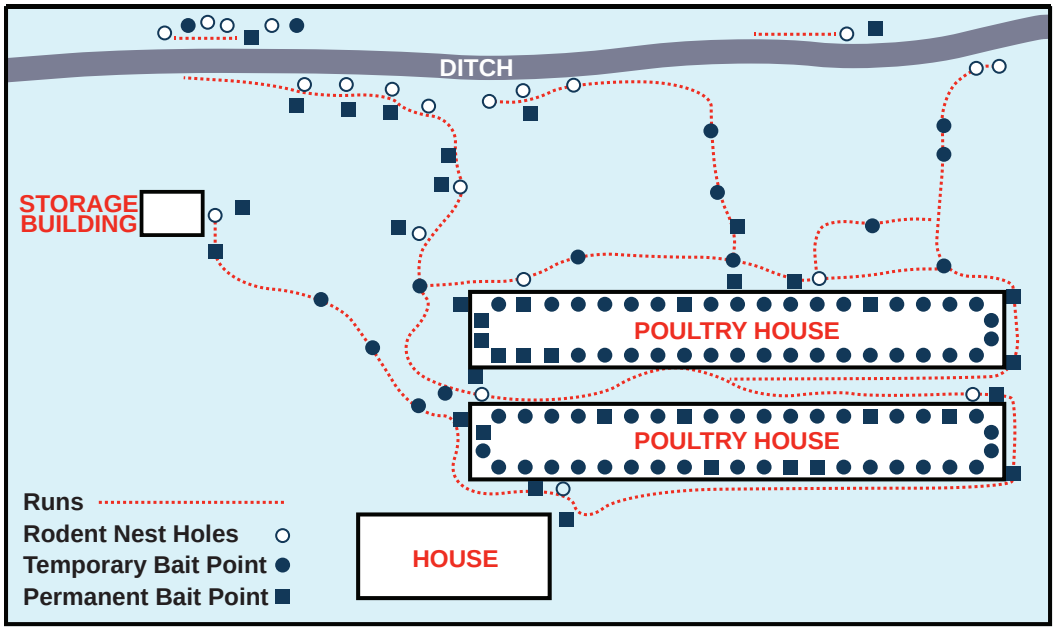
- Minimize the number of visitors and prevent unauthorized access to the farm.
- All people entering the farm should follow a biosecurity procedure including showering and a complete change of clothing.
- Maintain a record of visitors, including name, company, purpose of visit, previous farm visited, and next farm to be visited.
- When entering and leaving each poultry house, workers and visitors must wash and sanitize their hands and boots. In some instances, body sprays for disinfection are also used. **Figure 33** shows examples of both a foot dip and body spray.
- Tools and equipment carried into the house are a potential source of disease. Only necessary items should be taken in to the house and only after they have been properly cleaned and disinfected.
- If supervisory personnel are not able to avoid visiting more than one farm per day, they should visit the youngest flocks first.

Figure 33: Use of foot dips and body sprays before entering a poultry house.

Preventing Diseases Transmitted by Animals

- Whenever possible, place the farm on an “all in/all out” placement cycle.
- Downtime between flocks will reduce contamination of the farm. Downtime is defined as the time between completion of the cleaning disinfection process and placing the next flock. Decisions on length of downtime is an economic one but the longer downtime between flocks is the lower the risks of disease transmission between flocks will be.
- Do not leave equipment, building materials or litter lying around. This will reduce cover for rodents and wild animals.
- Clean-up feed spills as soon as they occur.
- Store litter material in bags or inside a storage building or bin.
- Keep wild birds out of all buildings by ensuring it is adequately sealed against wild bird access. Any holes or gaps should be covered.
- Maintain an effective rodent/vermin control program this should include mechanical, biological, and chemical controls. Baiting programs are most effective when followed continuously. An effective vermin control program is given in **Figure 34**.

Figure 34: Example of a rodent baiting plan.



Vaccination

Vaccination prepares the bird against field challenges caused by specific pathogens by exposing birds to a safe form of the infectious organism (antigen). In today's environment correct vaccination procedures are an essential part of managing broilers.

An appropriate vaccination program should be developed in consultation with a veterinarian, taking into account the local disease challenges. The table below lays out some essential factors for successful vaccination of broilers.

Table 8: Factors for a successful vaccination program.

Vaccination Program(s) Design	Vaccine Administration	Vaccine Effectiveness
Programs must be based on veterinary advice tailored to specific local and regional challenges established by health surveys and laboratory analysis. Carefully select single or combined vaccines according to age and health status of flocks. Vaccination must result in the development of consistent levels of immunity while minimizing potential adverse effects. Breeder programs should provide adequate and uniform levels of maternal antibodies to protect chicks against several viral diseases during the first weeks of life. Maternal antibodies may interfere with the chick's response to some vaccine strains. Levels of maternal antibodies in broilers will decline as the breeder source flock ages.	Follow manufacturer recommendations for product handling and method of administration. Properly train vaccine administrators to handle and administer vaccines. Maintain vaccination records. When live vaccines are given in chlorinated water, use a vaccine stabilizer (such as non-fat powdered or liquid milk) added to the water prior to the vaccine to neutralize the chlorine. Chlorine can reduce vaccine titer or cause inactivation.	Seek veterinary advice prior to vaccinating sick or stressed birds. Periodic and efficient house cleaning followed by placement of new litter material reduces the concentration of pathogens in the environment. Adequate downtime between flocks helps to reduce the build-up of normal house pathogens that can affect flock performance when re-using litter. Regular audits of vaccine handling, administration techniques, and post-vaccinal responses are critical to control challenges and improve performance. Ventilation and management should be optimized post-vaccination, especially during times of vaccine-induced reaction.

Vaccination Methods

Individual Vaccination

- Vaccination of individual birds by injection or eye drop is effective and generally well tolerated by the birds, but it is labor intensive.
- Every bird must receive the intended dose of vaccine.

Spray Vaccination

- Vaccination by spray requires less labor and can be highly effective, but must be administered using the correct procedures.
- All curtains must be closed to ensure that the vaccine is spread evenly throughout the flock.

Drinking Water Vaccination

- This form of vaccination must be carried out with the greatest care if it is to be effective.
- The water used for preparing the vaccination solution must not contain any disinfectant or chlorine residue.
- It is recommended to use a water stabilizer for all water vaccination.
- For drinking water vaccination, clean and drain all water lines before applying vaccines.
- It is recommended to vaccinate during the coolest part of the day.
- Water intake at an age must be known if this type of vaccination is to be completed successfully.

Disease Investigation

Disease investigation requires knowledge of what to expect at what age and how to detect what is abnormal for the flock. It is important to be familiar with the normal production parameters or standards for the breed.

- Routine laboratory monitoring of the disease status of a flock will help develop an understanding of the flock's normal serological baseline.
- When health problems are seen or suspected in broiler flocks, seek veterinary advice immediately.
- Keep up-to-date with local and regional health concerns and be aware of any potential disease challenges.

A systematic approach is required when troubleshooting health issues on the farm. These are the things to look at:

- **Feed**: Availability, consumption, distribution, palatability, nutritional content, contaminants, and toxins.
- **Light:** Adequate for efficient growth and development, uniform exposure and intensity.
- **Litter:** Material used, depth, distribution, moisture level, pathogen load, toxins, and contaminant.
- **Air:** Speed, availability, humidity, temperature, contaminants (ammonia level and toxins), and barriers.
- **Water:** Availability, consumption, distribution, source, contaminants and toxins, pathogen load, additives, and sanitizers.
- **Space:** Bird density, limiting obstacles, limiting equipment, feed and water availability.
- **Sanitation:** Hygiene of premises, pest control, maintenance, cleaning and disinfection practices (house and grounds, feeders, drinkers, feed bins.)
- **Security:** Biosecurity risks (house design and biosecurity practices).

Tables 9 and **10** highlight examples of mortality parameters possibly related to bird quality and bird health. The tables also suggest potential investigative actions using the approach for troubleshooting health issues outlined above.

Table 9: Troubleshooting common issues in the 0-7 day brooding phase.

Observe	Investigate	Likely Causes
Poor Chick Quality: Increased dead on arrivals (D.O.A.) Chicks inactive and slow to respond, lacking energy General chick appearance: • Unhealed navels • Red hocks/beaks • Dark wrinkled legs • Discolored or malodorous yolks or navels	**Feed, Sanitation, Air, and Water:** Source flock health and hygiene status Egg handling, storage, and transport Hatchery sanitation, incubation, and management Chick processing, handling, and transport	 Inadequate diet of source flock Health and hygiene status of source flock, hatchery, and equipment Incorrect parameters for egg storage, relative humidity, temperatures, and equipment management Incorrect moisture loss during incubation Incorrect incubation temperature Dehydration caused by excessive spread of hatch time or late removal of chicks
Small Chicks Days 1-4	**Feed, Light, Air, Water, and Space:** Crop fill at 24 hours post chick placement Availability and accessibility to feed and water Bird comfort and welfare	 Less than 95% of chicks with adequate crop fill by 24 hours post placement Weak chicks Inadequate feeders and drinkers Inadequate feed and water levels Equipment location and maintenance issues Inappropriate brooding temperature and environment
Runted and Stunted Chicks: Small birds, as early as 4-7 days	**Feed, Light, Litter, Air, Water, Space, Sanitation, and Security:** Flock source Hydration status of chicks Brooding conditions Feed quality and accessibility Downtime between flocks Disease challenge	 Chicks sourced from widely different flock ages Chicks unable to find or reach water Incorrect brooding temperatures Chicks unable to find feed or poor feed quality Short downtimes between flocks Inadequate cleaning and disinfection Disease Poor biosecurity and hygiene practices

Table 10: Troubleshooting common issues after 7 days of age.

Observe	Investigate	Likely Causes
Disease: Metabolic Bacterial Viral Fungal Protozoal Parasitic Toxins	**Feed, Light, Litter, Air, Water, Space, Sanitation, and Security:** Broiler farm hygiene Local disease challenge Vaccination and disease prevention strategies Feed quality and supply Lighting and ventilation	 Poor environmental conditions Poor biosecurity High disease challenge Low disease protection Inadequate or improper implementation of disease prevention Poor feed quality Poor bird access to feed Excessive or insufficient ventilation
Stress	**Potential stressors:** Temperature Management Immunosuppressive disorders	 Inadequate farm management Inadequate equipment Inadequate bird comfort and welfare
High Number of Birds D.O.A. to the Processing Plant: High plant condemnation rate	**Feed, Light, Litter, Air, Water, Space, Sanitation, and Security:** Flock records and data Health status of flock History of flock during the grow-out period (such as feed, water or power outages) Potential equipment hazards on the farm Bird handling by the catchers, handlers, and transporters Experience and training level of individuals handling and transporting birds Conditions during catching and transporting (such as weather and equipment)	 Health issues during grow-out Management of relevant historical events affecting bird health and welfare Improper bird handling and hauling by crews Harsh conditions (weather or equipment related) during handling, catching or transport to the processing plant

KEY POINTS:

- A clear program of hygiene management should be in place for site biosecurity, cleaning and disinfection.
- Appropriate planning and evaluation of the cleaning and disinfection procedures should be in place.
- Adequate biosecurity will prevent disease from both animals and humans.
- Vaccination is more effective when disease challenge is minimized through a good biosecurity program.
- Vaccination programs should be developed in consultation with poultry trained veterinarians.
- Knowledge of what is normal for a flock and being alert to any deviations from expectations are key for disease investigation.
- Observe. Investigate. Identify. Act

Appendices

Appendix 1 - Record Keeping

Record keeping and analysis are essential to determine the effects of changes to nutrition, management, environment, and health status. Accurate production records are essential for effective management.

Analysis and interpretation of production data (e.g. live weight, feed conversion efficiency, and mortality) are essential to the upgrading and improvement of performance.

Hygiene and disease status should be monitored.

It is good practice for all processes in a broiler operation to have standard operating protocols (SOP). These should include documentation of established procedures, records, record analysis, and monitoring systems.

Records Required in Broiler Production

Event	Records	Comment
Chick placement	Number of day-olds Flock of origin and flock age Date and time of arrival Chick quality Crop fill	Live weight, uniformity, number of dead on arrival Check crop fill percentage for age
Mortality	Daily Weekly Cumulative	Record by sex if possible Record culls and reason for culling separately Post-mortem records of excessive mortality Scoring of coccidial lesions will indicate level of coccidial challenge Record actual numbers and percentages Particular importance should be paid to 7-day mortality
Medication	Date Amount Batch number	As per veterinary instruction
Vaccination	Date of vaccination Vaccine type Batch number	Any unexpected vaccine reaction should be recorded
Live weight	Weekly average live weight Weekly uniformity (CV%)	More frequent measurement is required when predicting processing weight

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Event	Records	Comment
Feed	Date of delivery Quantity Feed type Feed form Date of starting feed withdrawal prior to catching	Accurate measurement of feed consumed is essential to measure FCR and to determine cost effectiveness of broiler operation Check feed quality
Water	Daily consumption Water to feed ratio Water quality Level of chlorination	Plot daily consumption in graph form, preferably per house Sudden fluctuation in water consumption is an early indicator of problems Mineral and/or bacteriological especially where bore holes or open water reservoirs are used
Environment	Temperature: • Floor temperature as well as litter temperature -daily minimum -daily maximum -during brooding, 4 to 5 times per day -litter during brooding -external temperature (daily) • Relative humidity (daily) Air quality Litter quality Last calibration of equipment and by who	Multiple locations should be monitored, especially in chick litter area Automatic systems should be cross-checked manually each day Ideally record dust, CO_2, NH_3 or as a minimum observe levels of dust and NH_3
Depletion	Number of birds removed Time and date of removal	
Information from processing plant	Carcass quality Health inspection Carcass composition Type and % condemnations	
Cleaning out	Total bacterial counts	After disinfection, salmonella, staphylococcus or E. coli may be monitored if required
House inspection	Record time of daily checks Make note of any bird observations	 Behavior and environmental conditions
Lighting program	Dark and light period Time on and time off	Intermittent or not
Visitors	Who Date Reason for visit Previous farm visits (place and date)	Should be completed for every visitor to ensure traceability

Appendix 2 - Feeding and Drinking Equipment

Equipment needed per 1000 broilers.

	Brooding (day 1-14)	Post Brooding (day 14-42)
Tray feeder	10	
Tube feeder		15
Pan feeder		22-13 or 45-80 birds per pan (the lower ratio for bigger birds [>3.5 kg/7.7 lb])
Supplemental drinker	10	
Bell drinker	10 if using	8 drinkers (40 cm diameter) per 1000 birds
Nipple drinker		83 nipples per 1000 birds (12 birds per nipple, or for broilers >3 kg, 9-10 birds per nipple)

Appendix 3 - Broiler Feed Type Example

Type of Feed	Age	Form of Feed
Broiler Starter	0-10 days	sieved crumbs
Broiler Grower	11-24 days	2-3.5 mm diameter pellets
Broiler Finisher	25 days to processing	3.5 mm diameter pellets

For further information, please contact your local Aviagen representative.

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