ECOLOGICAL EGG PRODUCTION SYSTEMS

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SUMMARY

INTRODUCTION

The Brazilian government has in place a National Program for the Support Ecological-Based Agriculture (BRASIL, 2005), which aids the development of different alternative agricultural systems, including ecological, organic, biological, natural, biodynamic and permaculture production in Family Production Units.

These systems alternative to industrial production are usually practiced on small and family farms, and although they have different guiding principles and production practices, all aim at achieving the sustainability of agroecosystems by reducing or eliminating the use of chemicals and improving the sensorial quality of their products.

Considering that practices of the above-mentioned alternative models are very similar when applied in egg production, they will be collectively referred as ecological egg production in this document.

Ecological poultry production is an alternative model for the production of poultry meat and eggs in compliance with the poultry health and public health, animal welfare, and environmental sustainability requirements of the official Veterinary Service (SVO) set forth in the Brazilian legislation. It increases the income obtained in small farms, thus contributing to improve the living conditions of farmers.

This publication provides information on genetics, facilities and equipment, biosecurity, management practices applied during pullet rearing and development phases and during lay, outdoor range management, as well as feeding and water management practices applied in ecological egg production systems. The aim is to provide guidelines for farmers and technical personnel, as well as support those who wish to invest in this sector to achieve the best possible performance.

PUREBRED AND HYBRID GENETIC LINES

Useful information:

Pure layer breeds: Birds that have been submitted to selective breeding in order to preserve desirable traits, such as eggshell color, adaptation to specific environments, etc. Pure breeds are the basis for crossbreeding to develop hybrid lineages or strains. Example: Rhode Island Red.

Hybrid layer strains: are obtained by crossbreeding different breeds or strains in order to obtain the best traits of the parent breeds. In layers, the ultimate aim is high egg production. Example: Embrapa 051 strain.

The following pure breeds and hybrid strains can be used for ecological egg production:

Pure breeds

Photo: fazendavisconde.com.br

Rhode Island Red: it is a dual-purpose breed, i.e., it is reared both for egg and meat production. Hens produce 180-240 eggs per year. The eggs are brown and large, weighing 56 to 65 g. On average, males weigh 3.8 kg and females 2.8 kg.

Photo: fazendavisconde.com.br

Plymouth Rock: barred and white are the most commonly reared varieties of this breed. It is a dual-purpose breed. On average, males weigh 4.3 kg and females 3.1 kg. Hens lay around 180 brown eggs per year.

Photo: fazendavisconde.com.br

New Hampshire: it is also a dual-purposed breed with light-brown feathers. Males are used for meat production, and weigh 3.8 kg, on average. Females lay 220 brown eggs/year, and weigh about 3 kg.

Hybrid layer strains

Hybrid layer strains may have dual purpose, with males used for meat production. Females are used for the production of commercial eggs (table eggs) and may also be used for the production of meat or meat products at the end of the egg-production cycle.

Embrapa 051: produce brown eggs. Females weigh 2.38 kg, on average, at 90 weeks of age and present a cumulative average production of around 345 eggs during lay. This strain is recommended for semi-confined or free-range (with access to pasture) systems, and may be processed for meat production by the end of the production cycle.

Photo: Lucas S. Cardoso

Backyard chickens: produce table eggs under a differentiated system, and may be used for meat production at the end of their production cycle.

Useful information:

- Although presenting higher production rates than pure breeds, the lineages should not be reproduced on the property. New lots must be purchased from certified suppliers from the Official Veterinary Authority to ensure healthy and productive stock renewal.
- The advantage of purchasing certified hatchery chicks is safety from major diseases, as sanitary control is tight and monitored by the Animal Health Officers.

LOCATION AND FACILITIES

The local authorities should be contacted to obtain their authorization before the implementation and operation of an ecological egg-production system..

- **Environmental Agency:** authorizes the farmer to build the system at the intended location, thereby ensuring that the system complies with the official requirements for environmentally sound production.

- **Local Animal Health Protection Agency:** needs to be contacted to verify the need for farm registration and compliance with other requirements.

- **National Health Surveillance Agency:** establishes the requirements for the sale of table eggs in the market in order to prevent consumer health risks.

In ecologically-based systems, the sheds and free-range areas (paddocks) need to be planned by the farmer according to the area required in each system. Table 1 shows the normative requirements for organic and free-range poultry production systems.

Table 1. Stocking density with or with no paddock rotation.

Required area	Shed (N. birds/m²)	Paddocks (m²/bird)	Paddock rotation
Organic system			
Hens	6 birds/m²	3 birds/m²	No rotation
Hens	6 birds/m²	1 birds m²	With rotation
Free-range system			
Hens	7 birds/m²	At least 0.5 m²/hen	With rotation

Source: BRASIL (2011); ABNT (2016).

Sheds

Birds may be housed in an existing facility, provided it is adapted as a poultry shed. In the case of new shed, it should be built on a slightly-sloped site with good soil drainage capacity in order to prevent water accumulation around the shed. The facilities may be adapted or built using simple materials existing on the farm, provided they allow proper cleaning and sanitation. Figure 1 shows a shed and its respective equipment. An example of a floor plan, front and side facades and cross section is given in Annex 1.

The shed can have dirt or concrete floor, which should be covered with litter. The typical litter substrates used are wood-shavings (from non-chemically treated wood), rice husks, chopped and dry grass, or straw. The litter should be replaced whenever it is damp, particularly under leaking drinkers.

Paddocks

The paddocks are the extension of the hens' rearing environment and therefore, should receive the same attention and care as the shed. Paddocks may be internally divided using electric fences (Figure 2). The paddocks should have proper drainage capacity, and should not be established low areas where water accumulates. In addition, shaded areas should be established to provide shelter to the birds during the period they remain in the paddock. Paddock vegetation should be composed preferably of grass species adapted to the region. Stoloniferous (creeping) grass species provide good soil protection and have adequate regrowth capacity. Some suggestions for the green cover (grasses or legumes) of paddocks are bermudagrass (*Cynodon dactylon*), African stargrass (*Cynodon plectostachyus*), Korovinia grass (*Brachiaria humidicola*) and Pinto peanut (*Arachis pintoi*), among others with similar characteristics.

A rotational system should be applied in the paddock. The fallow period favors the natural incorporation of the excreta into the soil and pasture regrowth. Moreover, it provides downtime to allow natural reduction of parasite load and disinfection in the area, thereby promoting animal welfare and the sustainability of the production system. Paddock rotation must be based on pasture degradation status in each paddock. When necessary, rotation can be performed more frequently. It is recommended to use at least four paddocks per shed, so that the birds graze for a maximum period of one week, with a fallow period of at least 21 days. However, the number of divisions may be higher, increasing fallow intervals to 35 days or reducing the permanence of the flock in each paddock, allowing pasture regrowth and natural disinfection, as shown in Figure 1.

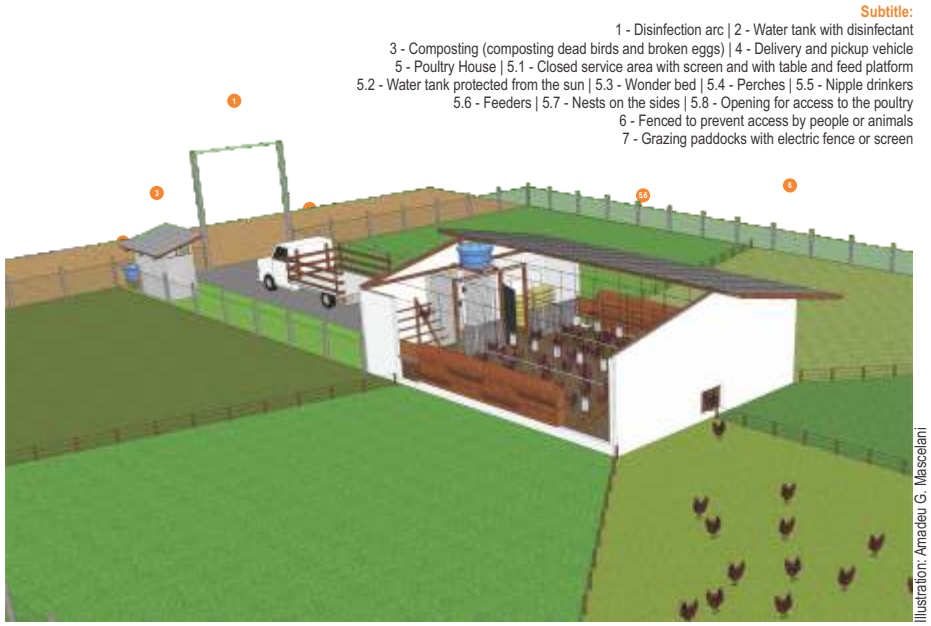


Figure 1. Egg production system using paddock rotation.


Photos: Valdir S. Ávila

Figure 2. Electric fence for the division of paddocks.

Other facilities

In addition to the sheds and paddocks, suitable locations for feed manufacturing, egg reception and storage, as well as a space for an office and a restroom for the workers should be provided.

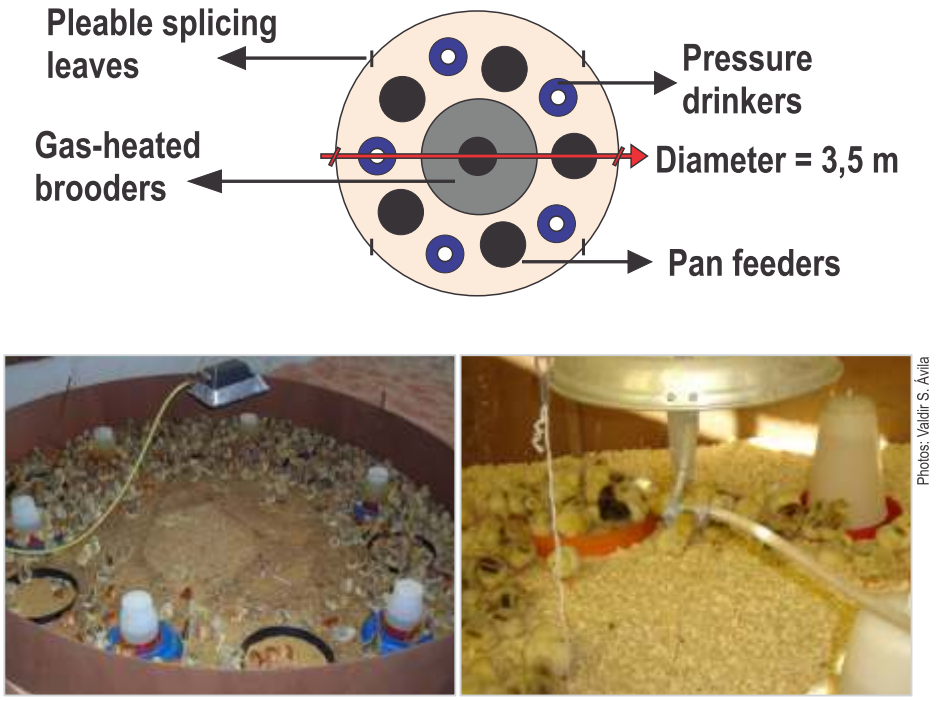
MANAGEMENT PRACTICES DURING THE REARING AND DEVELOPMENT STAGES

Pullet reception

At the time pullets arrive on the farm, it must be ensured that all shed equipment are fully functional, and that the shed environmental conditions are adequate. The brooding circles or housing area should be heated to 32-35C, and water and feed readily available.

Inside the brooding circles, the litter may be covered with three layers of paper (e.g., newspaper), removing one layer per day. The main objectives of this procedure are to spread some feed on the paper to stimulate pullet feed intake, and to reuse feed spilt from the feeders.

During the first days of life, chicks should be kept close to heat, water and feed sources. Pliable wood, metal, or cardboard plates can be used to build the brooding circles, making sure there are no corners. Drinkers and feeders should be evenly distributed within each circle, as shown in Figure 3. Gas-heated brooders are more commonly used. Wood-heated brooders may also be used, provide they are equipped with a chimney to remove the smoke, which is harmful to the birds.



Photos: Valdir S. Ávila

Figure 3. Example of a brooding circle for 500 chicks.

Note: Around 60-80 chicks should be housed per square meter of brooding circle.

Useful information:

- The brooding circles should be gradually enlarged according bird age in order to increase the space available to the birds. However, ensure that room temperature is adequate to bird age before this procedure. During colder seasons, brooding circles can start to be enlarged when birds are 12 to 15 days of age, and around 10 days of age in the summer.

Internal shed temperature is controlled by curtain and brooder management. Curtains usually remained closed all day during the first week of housing. During the second week, curtains may be opened halfway during the day and closed at night, depending on external environmental temperature, as shown in Table 2.

Table 2. Adequate temperature according bird age.

Period	Temperature
Day 1	32º to 34º C* / 89,6º to 93,2º F**
Days 2 - 7	30º to 32º C / 86º to 89,6º F
Week 2	28º to 30º C / 82,4º to 86º F
Week 3	25º to 28° C / 77º to 82,4º F
Week 4	22º to 25º C / 71,6º to 77º F
After week 5	18º to 22º C / 64,4º to 71,6º F

* Celcius; ** Fahrenheit

Chick behavior inside the brooding circle will signal the need to increase or not the temperature for their comfort and welfare (Figure 4).

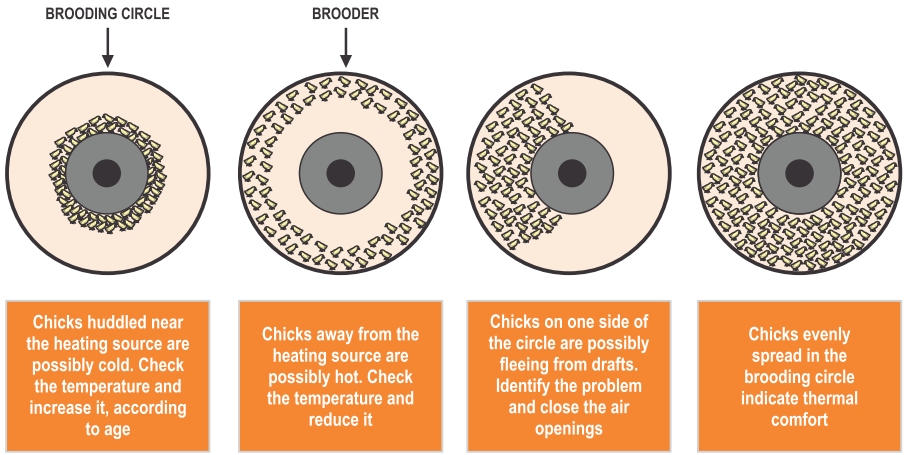


Figure 4. Behavior of chicks submitted to different temperatures.

Equipment for pullet rearing and development phases

Simultaneously to the enlargement of the brooding circle, chick feeders and drinkers should be replaced by equipment for mature birds, except when single-stage equipment are used, such as nipple and bell drinkers, and tube and automatic feeders.

Photo: Valdir S. Ávila

Feeders

Pan feeders: are usually made of aluminum or plastic. They should available during the first few days at a ratio of one feeder per 80 chicks, and be replaced at 10 days of age by adult feeders.

Tube feeders: are usually made of aluminum or plastic. They should be available during the first few days at a ratio of one feeder per 80 chicks, and be replaced at 10 days of age by adult feeders.

Photos: Jairo Backes

Drinkers

Pressure drinkers: should be available during the first few days at a ratio of one drinker per 60 chicks. Drinkers should be cleaned and the water changed at least twice daily. This equipment allows the use water medication, when necessary. They should be replaced at 10 days of age by adult drinkers.

Photo: Valdir S. Ávila

Bell drinkers: When used from the first day (at a ratio of one/80 chicks), drinker height should be adjusted to allow birds to drink comfortably, while preventing them to step on the pan and getting wet. This equipment also allows the use water medication, when necessary.

Photo: Valdir S. Ávila

Nipple drinker: This equipment can be used from the first day of life. Adjust drinker height and water pressure throughout the shed to allow adequate and comfortable water consumption of 12-14 chicks per nipple.

Photos: Jairo Backes

Equipment for mature hens

Feeders

Several models, made of different materials, can be used.

Photo: Valdir S. Ávila

Tube feeders: it is a simple feeder that stores a determined volume of feed as a function of its size. Depending on feed type, the feeder may need to be shaken to allow the feed to properly fall into the pan. One pan feeder for every 25 pullets or mature hens is recommended.

Photo: Márcio G. Saatkamp

Automatic pan feeders: are also widely used. They require less labor and the recommendation is for one feeder for every 25 birds. Both tube and automatic feeders should be placed at the height of the birds' back.

Drinkers

Photo: Lucas S. Cardoso

Bell drinkers: allow excellent water supply for mature hens. The general recommendation is one for every 40 birds.

Photo: Valdir S. Ávila

Nipple drinkers: allow clean water supply, as well as low litter moisture. The general recommendation is one nipple for every 8-10 adult birds, and should be adjusted according to bird age and height.

Figure 5 shows tube feeder and bell drinker height relative to bird height. When using nipple drinkers, water flow/pressure should be monitored to ensure adequate water consumption.

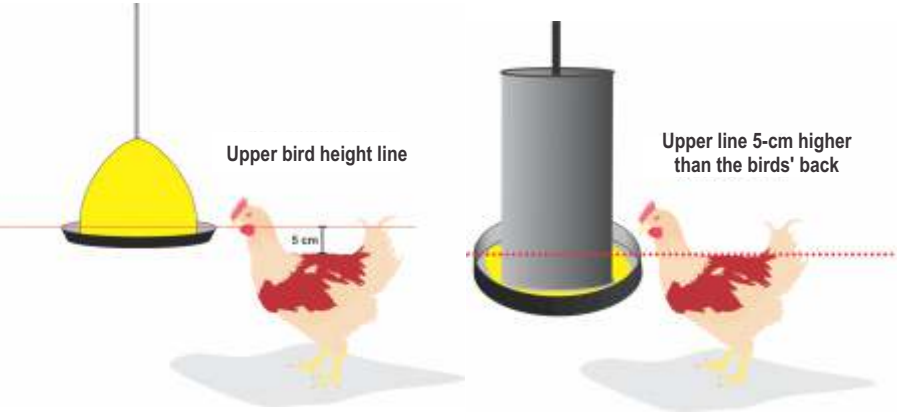


Illustration: Roberto Marca

Figure 5. Tube feeder and bell drinker height relative to bird height.

PULLET MANAGEMENT

From 30 days of age, pullets can have access to the outdoor area. Do not release birds on rainy days or when the paddocks have excessive moisture in order to maintain paddock pasture and environmental sustainability and to ensure bird health and welfare. Pullet sexual maturity rate increases around 16 weeks of age

and is reached around 17-19 weeks of age, when laying begins, and the lighting program is put in place.

Lighting program

Light stimulates the development and maturation of the reproductive system. It is responsible for synchronizing the start and maintenance of the egg production curve during the hen's production life. The lighting program should provide about 4.5 watts/m2 and should reach 16 hours of total daylight using natural light plus artificial light should reach. It should be set up according to season and bird age and genetics. Table 3 shows an example of a lighting program for layers, considering artificial and natural light.

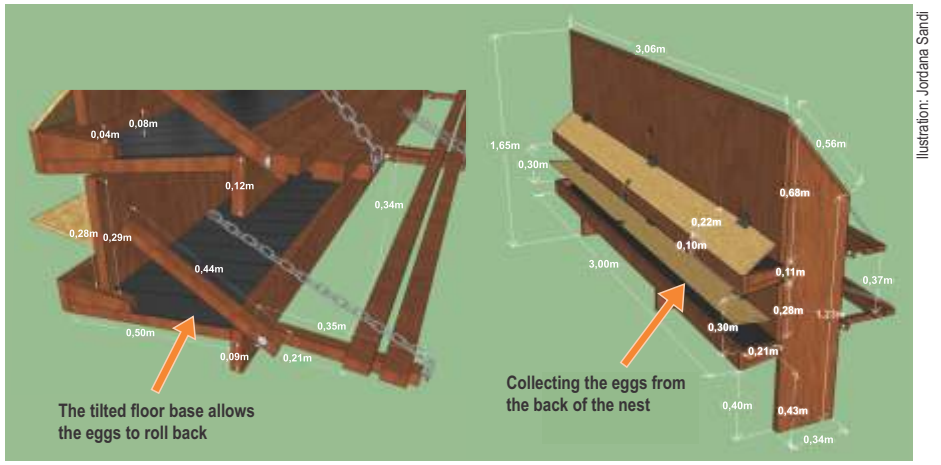
Table 3. Lighting program for layers.

Period	Lighting management
1 day of age	At housing, provide 24 hours of light and reduce 2 hours of light daily until reaching the natural light period. Maintain birds under natural light until 10 weeks of age
10-17 weeks of age	**Provide natural light:** during periods of decreasing sunlight (from January to June in the southern hemisphere) **Provide constant light:** (13 to 14 hours/light/day) natural + artificial light during increasing sunlight periods (from july to december)
From 17 weeks of age	**Provide gradual light increase:** (natural + artificial), add 30 min of light, divided in 15 min in the morning and 15 min in the evening every two to three days, until reaching 16 hours daily, which should be maintained until the end of the egg production cycle

Near the beginning of lay, nests should be set up in the shed and made available to the hens. In addition, set up perches as part of the shed equipment to promote bird welfare.

Nests

Ready-made nests can be purchased in the market or manufactured with wood on the farm. Some new models allow the eggs to roll to the back of the nest, preventing hen contact with the eggs and allowing easier egg collection, as in the model below (Figure 6). For more information on how to build of this nest model, see the folder on nests adapted for layers (Saatkamp; Avila, 2016).



Ilustration: Jordana Sandi

Figure 6. Tilted collective nest.

Perches

Perches can be made of wood, making it easier for the hens to grasp and to stay on the perch. Perches should be placed at the ends or sides of the shed at a 30-40° angle relative to the wall and floor. Perches should provide 15-cm linear space per bird, allowing most of the birds in the shed to perch at the same time.

Photo: Valdir S. Ávila

MANAGEMENT DURING LAY

It is considered that the flock starts egg production when 5% of the hens lay eggs on the same day. For instance, when a flock of 100 hens laid five eggs on the same day, it is considered that the flock reached sexual maturity and started the egg production cycle.

Egg production curve

Layers of most genetic strains start to lay eggs around 19 weeks of age. Egg production gradually increased until the peak of lay, at around 28 weeks of age, as shown in Figure 7. The time of flock culling is determined by the farmer based on cost-benefit considerations.

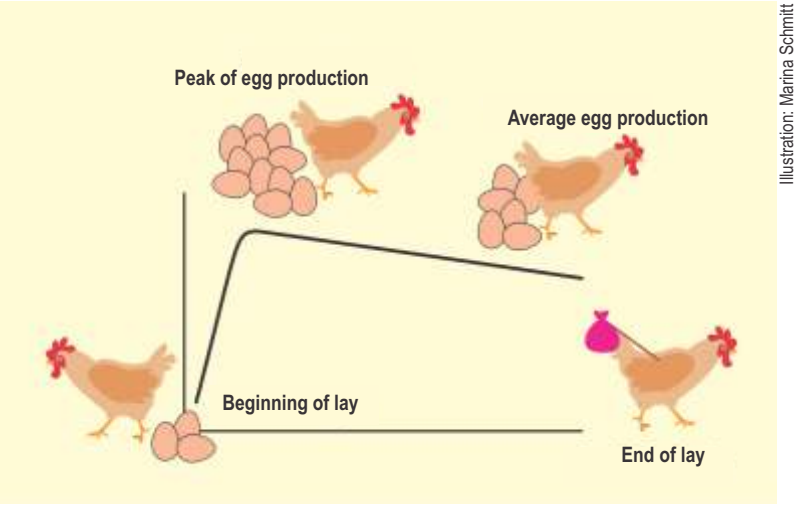


Illustration: Marina Schmitt

Figure 7. Egg production curve.

Identifying hens in lay

During the egg production cycle, hens present specific characteristics that can be assessed by the farmer with the aim of culling unproductive hens (Rosa et al., 2007). Table 4 shows the relevant characteristics that differentiate hens in lay from those not producing eggs.

Table 4. Identification of unproductive hens.

Characteristics of hens in lay	Characteristics of hens not laying eggs
Silky and reddish crest and wattle	Small, dry, and darkened crest and wattle
Oval, enlarged, not pigmented, and damp vent	Narrow, circular, pale and dry vent
Distance between the pelvic bones (hip bones) of 3 to 4 fingers	Distance between the pelvic bones of only two fingers
Soft, prominent abdomen, whitish feet and beaks	Hard and small abdomen

BIOSECURITY

What is biosecurity?

It is a set of actions and procedures that aim at protecting the flock and minimizing the entrance of pathogens on the farm.

- **System isolation:** keep the production system isolated and distant from other animal production systems.
- **Housing per production unit and flock age:** flocks of different ages must be housed in separated sheds.
- Farms must be registered at the Official Veterinary Service (SVO) and comply with current legislation. The following minimum biosecurity precautions must be in place:
  - Infrastructure for changing garments and footwear and for technical visits.
  - Disinfection station for vehicles entering and leaving the single access point to the farm.
  - Isolation fence of at least 1-m high placed at a 5-m distance from the shed to prevent the access of unwanted animals and signs indicating that the entrance of visitors in the shed is prohibited.
  - Sheds should be protected from the external environment by a wire mesh with openings not larger than 2.54 cm to prevent the access of wild birds that may carry or spread infectious agents.
  - An appropriate disposal site for dead carcasses and culled eggs, using composting or other methods capable of inactivating pathogens and in compliance with current environmental legislation.
- Day-old chicks or pullets must be purchased from breeding farms that are registered and certified by the Official Veterinary Service (SVO), in compliance with current legislation.
- A vaccination program complying with current legislation and based on local health challenges should be applied in the hatchery and on the farm.
- The farm must have an integrated rodent control. Implement, maintain and record pest and rodent control.

Basic cleaning, disinfection and downtime procedures

Keep the internal areas of the sheds clean and organized, free of unnecessary items. Garbage should be properly disposed during the entire production cycle. Chick delivery cardboard boxes should be incinerated immediately after the chicks are housed.

Cleaning

During downtime, clean the facilities according to the recommended procedure. At the end of each production cycle, after birds are removed, the litter and all pieces of equipment must be removed from the shed. Use a blowtorch on the wire mesh, floor, and wherever possible inside the shed. Thoroughly wash all equipment (feeders, drinkers, curtains, etc.) and the entire shed with water and detergent. Establish the downtime period according to technical recommendations before the next flock is housed.

Disinfection

During downtime, disinfect the facilities after cleaning according to the recommended procedures, check expiration date of the disinfectants and strictly follow the manufacturer's recommendations to prepare the disinfection solution. In sheds with dirt floors, cresol-based disinfectants are recommended, as they are not inactivated by the presence of organic matter (excreta and feed residues), it has good residual power, and it is biodegradable, that is, it is susceptible to decomposition by soil microorganisms. After disinfection, the shed must be maintained closed for four hours.

Downtime

The “all-in, all-out” management system should be applied in all sheds, which means a single-age flock is housed and removed at the end of the production cycle. After cleaning and disinfection, the shed may be whitewashed. Next, spread new, clean, and dry litter material, and keep the shed closed for at least 15 days. After this period, disinfect again, leave the shed closed for further two days, and prepare the equipment to receive the new flock of chicks.

Vaccination and deworming

The birds must be vaccinated according to the health program established by a trained veterinarian, who will take into account the health challenges present in the area. The veterinarian should also develop a deworming schedule. Free-range birds are more susceptible to gastrointestinal and pulmonary parasites, whereas those reared only inside the shed are more frequently infested with lice. The veterinarian monitoring parasitic diseases may need to necropsy dead, sick, or even healthy birds for a more accurate diagnosis. Table 5 shows an example of a vaccination program.

Table 5. Example of a vaccination program.

Age		Disease	Type	Route*	Dose
Day	Week				
1	1	Marek's disease Chicken pox	HVT + SB1 + Rispens mild	Sc Sc	1/1 1/1
7	1	Newcastle Infectious Bronchitis Gumboro disease	B-1 H120 Intermediate strain	Ed Ed Ed	1/1 1/1 1/1
35	5	Newcastle Infectious Bronchitis Gumboro disease	La Sota H120 Intermediate strain	Ed Ed Ed	1/1 1/1 1/1
49	7	Salmonella Infectious coryza	Live lyophilized vaccine Aluminum hydroxide	Im Im	1/1 1/1
70	10	Chicken pox Infectious Bronchitis Gumboro disease	Live attenuated vacines La Sota H120	Wing web injection Ed Ed	1/1 1/1 1/1
100	14	Infectious coryza Avian Encephalomyelitis Salmonella	Oil emulsion Live strain Live lyophilized vaccine	Im Water Im	1/1 1/1 1/1
112	16	Egg Drop Syndrome Newcastle Infectious Bronchitis	Oil emulsion Oil emulsion Oil emulsion	Im Im Im	1/1 1/1 1/1
315	45	Newcastle Infectious Bronchitis	Oil emulsion Oil emulsion	Im Im	1/1 1/1

Note: When necessary, birds should be vaccinated against Mycoplasma at 84 days of age via eye drop.
* Sc = Subcutaneous, Ed = Eye drop, Im = Intramuscular.

Useful information:

- Day-old chicks intended free-range production systems should be vaccinated against coccidiosis.

Photo: Jairo Backes

Vaccination methods

Intraocular (eye) or nasal drop: apply one or two drops on the eye. Vaccine drops should have uniform size. A bird is considered vaccinated when it closes the eyelid twice and the vaccine is absorbed.

Photo: Fátima R.F. Jaenisch

Oral route: this is a very convenient route to vaccinate large numbers of birds. Before vaccination, flush the drinker lines with pure non-chlorinated water, and prevent birds from drinking for two hours to stimulate vaccine consumption.

Photo: Luizinho Caron

Wing web route: the wing web is pierced with a needle previously dipped in the vaccine solution. This route is used for the vaccination against fowlpox. After 5 to 7 days, a lump will develop on the application site, indicating that vaccination was effective.

Photo: Jairo Backes

Injectable vaccines: can be applied by intramuscular route (breast and thigh muscles, in general), or by the subcutaneous route (under the skin of the neck). The needle should be disinfected after each application.

Important tips for the vaccination day

- Store the vaccines in a refrigerator at 2-8°C. Use ice boxes (styrofoam) with preservatives or ice.
- Use non-chlorinated and disinfectant-free water to dilute the vaccine and flush the drinkers or drinker lines.
- Ensure that enough drinkers are available for at least two-thirds of the flock, allowing immediate access to the vaccine.
- If possible, submit the flock to water fasting for one hour on hot days or two hours on colder days in order to stimulate fast vaccine intake.
- Vaccinate the flock during in the coolest hours of the day.
- Do not vaccinate sick birds.
- Incinerate unused vaccines.
- Do not keep unused vaccines.

Note: further tips on vaccination management can be found in Technical Circular 36 - How and why vaccinate breeders, broilers, and layers (Jaenisch, 2003).

Monitoring flock health status

Birds should be daily monitored for clinical signs of possible diseases or health conditions. Table 6 can be used a tool to aid monitoring flock health status. When needed, a veterinarian should be called.

Table 6. Characteristics that help differentiating healthy from sick birds.

Characteristics of a healthy hen	Characteristics of a sick
Active	Depressed
Actively searches drinkers and feeders	Prostrated (does not move)
Bright eyes	Cloudy eyes
Calm and attentive	Quiet and with eyes closed most of the time
The shed is quiet	Coughing and sneezing
Determined and steady gait	Wobbling gait, may not be able to stand, or shows paralysis
Firm stools	Diarrhea (whitish, hemorrhagic, etc.)
Maintains the head stable	The neck is arched or the head is constantly bent down
Body weight according to age	Body weight lower than that recommended
Scratching and pecking behavior	Underdeveloped breast
Normal egg production according to age	Egg production drop
Normal eggshells	Frequent eggshell and yolk defects

Routine management practices applied to layer flocks

- Daily rinse and change the water in the drinkers.
- The litter should be revolved as needed to prevent caking.
- Change the litter whenever it presents excessive moisture and caking.
- The removed wet and caked litter should be composted.
- At the exit of the flock, remove all the litter and compost it before using it as crop fertilizer.
- Proper composting inactivates the main pathogenic bacteria and viruses, as well as eggs and infective larvae of some parasites during the fermentation process.
- Do not allow birds out in the paddocks on rainy days or when air humidity is high.
- When paddocks are wet, treading by the birds damage the pasture and result in dirty eggshells.
- In dirty, damp environments, hens become frequently sick and are less productive due to worse welfare conditions.
- Do not supply moldy or fermented alternative feedstuffs (vegetable, root, and fruit residues).
- Fermented feedstuffs may cause diarrhea and other digestive disorders.
- Clean feeders whenever they are dirty or with leftover feed, especially when moist and fresh alternative feedstuffs are supplied.
- Store feed and alternative feedstuffs in dry, ventilated areas, and on pallets to prevent direct contact with soil, floors and walls.
- Store feed in areas protected from rodents and wild birds.
- Dead birds should be placed in closed containers to be composted at the end of the day.

Note:

- Collect the eggs at least four times daily.
- Keep nests clean and disinfected.
- The lighting program should be applied according to hen age.

FEED AND WATER

Water and feed must be supplied inside the shed to avoid attracting wild birds. Hens should be fed balanced feeds containing energy and protein sources, as well as minerals and vitamins to meet their nutritional requirements.

Feeds and their characteristics

Feeds are formulated to supply as best as possible the nutritional requirements of the hens. Therefore, feed formulas should not be changed or their ingredients replaced without technical knowledge, as the flock's production indexes may be compromised. Adequate feed formulation should consider:

- Available feedstuffs.
- Feedstuff cost.
- Characteristics and nutritional requirements of the breed or strain for which the feed l intender.
- Feedstuff nutritional characteristics, including antinutritional factors and digestibility.
- Feedstuff inclusion limits in the feed.

Useful information:

- Feeds and alternative feedstuffs supplied to layers under ecological systems must comply with the regulations of the Brazilian Ministry of Agriculture, and feedstuff reception, finished-product dispatch, and responsible technical person should be recorded.

Alternative feedstuffs and antinutritional factors

Feeds for monogastric animals, such as chickens, are typically based on corn and soybean meal as these feedstuffs are highly digestible. However, some of alternative feedstuffs may present antinutritional factors that impair their digestibility by the animals, limiting or preventing their inclusion in feeds. Antinutritional factors, such as those present in raw soybeans, can be inactivated by temperature and pressure, and therefore soybeans are roasted, cooked or extruded before they are included in poultry and pig feeds. Other fresh feedstuffs may contain toxic compounds, and when included in excessive levels, may cause diarrhea, as well as skin and egg yolk depigmentation. This emphasizes the need to precisely know the nutritional characteristics of the feedstuffs included in animal feeds.

Forages, fruits, and vegetables

Alternative feedstuffs, such as well-preserved forages, fruits and vegetables can be supplied in separate feeders inside the shed. Any leftovers should be disposed on the next day, before fresh feedstuffs are supplied. Chickens are not

able not efficiently utilize fiber-rich feedstuffs, and therefore, forages should be considered only as a supplement of the balanced complete feed.

Feed composition

The formulated feed must supply the birds' energy, protein, mineral, and vitamin nutritional requirements. Corn is traditionally used as an energy source in monogastric feeds, whereas soybean meal is used as a protein source. Trace minerals and vitamins are added to feeds in premixes or concentrates. Therefore, it is essential to understand that layers with differentiated performance potential will suffer nutritional restrictions if fed only corn and vegetable residues, for instance. This highlights the importance of formulating diets adapted to the conditions of each specific production system and that supply the nutritional requirements of each genetic strain. Alternative feedstuffs available on the farm or in the area may be used, provided their characteristics, nutritional composition and inclusion limits are considered in diet formulation (Table 7).

Table 7. Examples of diet formulas with the inclusion of feedstuffs alternative to corn and soybean meal.

Formula Feedstuffs (%)	Starter phase		Grower phase		Laying			
	0 – 6 weeks		7 – 19 weeks		20 – 45 weeks		> 46 weeks	
	Ex. 1	Ex. 2	Ex. 1	Ex. 2	Ex. 1	Ex. 2	Ex. 1	Ex. 2
Oats	13,0	-	18,0	-	31,68	-	29,68	-
Wheat midds	10,0	-	15,1	17,5	-	-	-	-
Corn	42,0	43,3	42,0	10	27,85	-	29,8	-
Millet	-	-	-	-	-	26,5	-	26,6
Cottonseed meal	-	17,5	-	10	-	15	-	14
Roasted soybean	-	-	-	11,5	21,0	15	22,0	15
Soybean cake	32,2	21,5	12,0	-	-	-	-	-
Sunflower	-	-	-	10	-	23	-	23
Sunflower cake	-	-	-	-	8,0	-	6,0	-
Rice bran	-	15,0	-	20	-	-	-	-
Alfalfa hay	-	-	10,0	-	-	-	-	-
Cassava root	-	-	-	-	-	9	-	9
Dicalcium phosphate	1,2	1,25	0,92	0,56	1,65	1,59	1,65	1,59
Calcitic limestone	1,1	0,95	1,47	1,84	9,31	9,4	10,31	10,3
Salt	0,33	0,33	0,34	0,33	0,34	0,34	0,34	0,34
Vitamin premix	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
Mineral premix	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Formula Feedstuffs (%)	Starter phase		Grower phase		Laying			
	0 – 6 weeks		7 – 19 weeks		20 – 45 weeks		> 46 weeks	
	Ex. 1	Ex. 2	Ex. 1	Ex. 2	Ex. 1	Ex. 2	Ex. 1	Ex. 2
Nutritional information								
Metabolizable energy	2.860	2.852	2.745	2.732	2.812	2.848	2.804	2.828
Crude protein	20,3	20,3	15,0	15,8	15,7	17,8	15,6	17,5
Crude fiber	5,2	5,7	7,8	8,0	7,7	8,5	7,0	8,3
Total phosphorus	0,68	0,85	0,59	0,83	0,65	0,68	0,64	0,67
Available phosphorusl	0,42	0,42	0,36	0,36	0,42	0,42	0,42	0,42
Calcium	0,78	0,75	0,89	0,87	3,48	3,52	3,79	3,8
Sodium	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15
Total lysine	1,06	0,96	0,70	0,70	0,77	0,79	0,77	0,77
Digestible lysine	0,96	0,84	0,62	0,57	0,65	0,64	0,66	0,63
Total methionine	0,34	0,32	0,25	0,25	0,26	0,31	0,26	0,31
Total Met+Cys	0,72	0,65	0,58	0,53	0,65	0,63	0,63	0,61
Dig. Met+Cys	0,61	0,57	0,45	0,42	0,47	0,50	0,46	0,49

Source: Ludke, et. al (2010).

On-farm feed manufacturing

In addition to an appropriate place outside the production area, feed manufacturing on the farm requires correct equipment. Basically, to manufacture a diet containing corn, soybean meal and premix or concentrate, the following equipment is needed:

- Scales to weigh the feedstuffs (divisions of at least 100 g).
- Corn grinder
- Feed mixer.

Purchasing a commercial mixer is the best option. However, in small farms, simpler mixers may be used, such as those built of a barrel or tin, as shown in Figure 8, or even an adapted concrete mixer. It is essential to follow the correct technical recommendations when mixing the feeds, and avoid using the hands or a shovel for mixing, as this is not efficient.

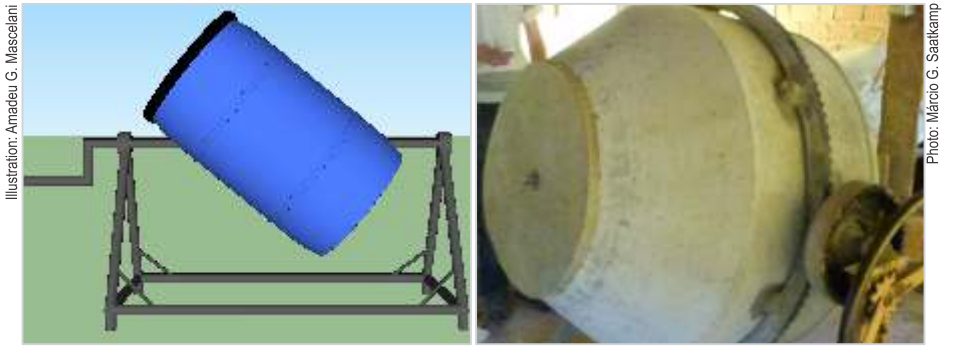


Illustration: Amadeu G. Mascelani

Photo: Márcio G. Saatkamp

Figure 8. Alternative feed mixer.

A drum with both ends closed can be used. Allow an opening for feeding the ingredients into the drum and to remove the feed after mixing. Two or three paddles should be welded on the center shaft to allow proper feed mixing. The mixer should be closed after mixing to prevent the access of rodents, and should always be cleaned after use, removing the feed crusts from the drum walls. Remember that it is essential to have a rodent control in place, including traps and proper monitoring.

Water

Water is the main nutrient required by the birds; therefore, it must be clean and have good quality. Drinking water temperature should not be lower than 15ºC or higher than 24ºC, and should be supplied ad libitum. Preferably, use farm water sources, stored in reservoirs and pipes protected from the sun. Water quality parameters should be analyzed, and the water should treated accordingly before it is supplied to the birds, in compliance with the legislation. Protecting the water source from direct or indirect contact with other birds is essential for the prevention of serious diseases, such as Newcastle disease and avian influenza, as well as other viral, bacterial, and parasitic diseases.

Water quality parameters for animal consumption

Water quality must meet the drinking standards set forth in Resolution No. 357 of March 17, 2005 of the Brazilian Environmental Council (Conama), which establishes that animal drinking water salinity to be equal to or lower than 0.5%, class 3 (BRASIL, 2005). The DFIP-DSA normative no. 1/2008, of the Brazilian Ministry of Agriculture (BRASIL, 2008) lists the water quality parameters that should be monitored on poultry farms, as shown in Table 8.

Table 8. Water quality parameters to be monitored on poultry farms and their acceptable limits.

Parameter	Level (mg/L)
Total dissolved solids (TDS)	<500
pH	6 a 9
Total hardness	<110
Chloride	<250
Nitrate	<10
Sulfate	<250
E. coli	Absence/100 mL

Source: Adapted from Brasil (2008).

MONITORING BIRD WEIGHT

In small farms, the weight of a sample of 5 to 10% of the flock should be weekly measured and recorded (Figures 9 and 10). Average body weight should be calculated and compared with the feed intake table of the breed or strain, such as that of Embrapa 051 layers (Tables 9 and 10 and Figure 11). The complete methodology for weighing pullet flocks by sampling to evaluate flock uniformity during rearing and development phases is described by Avila et al. (2007).

Photo: Márcio G. Saatkamp

Figure 9. How to contain birds for weighing.

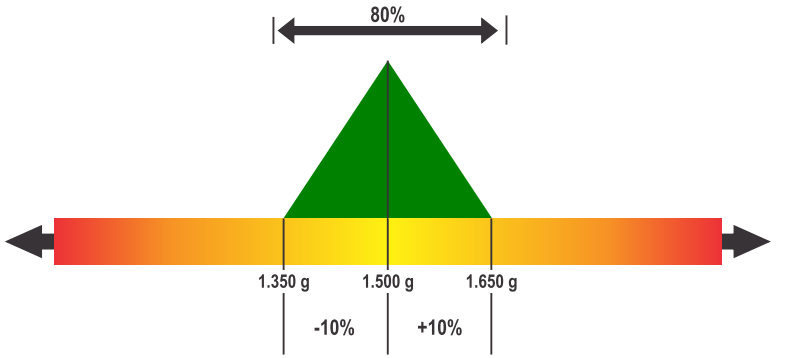


Figure 10. Flock uniformity chart: the goal is to reach at least 80% uniformity when pullets are 16-17 weeks of age, which means that the body weight of 80% of the flock should be close to the average. A limit of 10% of the flocks below or above the optimal average body weight recommended by the strain table is allowed.

Table 9. Body weight, feed intake, and livability of Embrapa 051 layers up to 19 weeks of age.

Weeks	Body weight (g)	Daily feed intake (g)	Cumulative feed intake (kg)	Total livability (%)
1	80	14	0,098	99,95
2	135	19	0,231	99,90
3	195	23	0,392	99,85
4	260	28	0,588	99,80
5	330	32	0,812	99,75
6	415	37	1,071	99,70
7	510	41	1,358	99,65
8	620	46	1,680	99,60
9	735	51	2,037	99,55
10	850	56	2,429	99,50
11	960	61	2,856	99,45
12	1.060	65	3,311	99,40
13	1.150	70	3,801	99,35
14	1.230	74	4,319	99,30
15	1.310	79	4,872	99,25
16	1.385	83	5,453	99,20
17	1.457	87	6,062	99,15
18	1.527	92	6,706	99,10
19	1.595	96	7,378	99,00

Table 10. Performance to achieve the goals of Embrapa 051 layers during lay.

Weeks	Body weight (g)	Egg production per hen housed, %	Cumulative egg production per hen housed	Egg weight (g)	Livability (%)	Daily feed intake (g)	Cumulative feed intake (kg)
20	1.662	0,52	0,06	46,66	99,00	100	8,078
21	1.728	8,81	0,53	47,42	98,97	104	8,806
22	1.791	30,62	2,57	48,14	98,94	108	9,562
23	1.845	55,35	6,48	48,85	98,92	111	10,339
24	1.894	74,56	11,94	49,53	98,83	113	11,130
25	1.939	84,80	17,58	50,18	98,73	114	11,928
26	1.981	88,85	23,51	50,81	98,64	115	12,733
27	2.018	90,45	29,66	51,42	98,55	115	13,538
28	2.052	90,71	36,01	52,00	98,46	115	14,343
29	2.082	90,35	42,38	52,56	98,37	115	15,148
30	2.110	89,73	48,56	53,10	98,27	115	15,953
31	2.134	89,10	54,81	53,62	98,18	115	16,758
32	2.156	88,48	60,93	54,12	98,09	115	17,563
33	2.177	87,85	67,18	54,59	98,00	115	18,368
34	2.195	87,23	73,42	55,05	97,91	115	19,173
35	2.212	86,61	79,62	55,48	97,81	115	19,978
36	2.217	85,98	85,74	55,90	97,72	115	20,783
37	2.221	85,36	91,85	56,29	97,63	115	21,588
38	2.225	84,74	98,00	56,67	97,54	115	22,393
39	2.228	84,11	104,08	57,03	97,45	115	23,198
40	2.232	83,49	110,05	57,38	97,35	115	24,003
41	2.235	82,87	115,89	57,71	97,26	115	24,808
42	2.239	82,24	121,36	58,02	97,17	115	25,613
43	2.242	81,62	126,91	58,31	96,08	115	26,418
44	2.246	81,00	132,40	58,59	96,99	115	27,223
45	2.249	80,37	137,73	58,86	96,89	115	28,028
46	2.252	79,75	143,09	59,11	96,80	115	28,833
47	2.255	79,12	148,42	59,34	96,71	115	29,638
48	2.259	78,50	153,64	59,57	96,62	115	30,443
49	2.262	77,88	159,10	59,78	96,53	115	31,248
50	2.265	77,25	164,49	59,98	96,44	115	32,053
51	2.268	76,63	169,80	60,16	96,34	115	32,858
52	2.271	76,01	175,01	60,34	96,25	115	33,663
53	2.274	75,38	180,13	60,50	96,16	115	34,468
54	2.277	74,76	185,28	60,66	96,07	115	35,273
55	2.280	74,14	190,43	60,80	95,98	115	36,078
56	2.283	73,51	195,68	60,93	95,88	115	36,883
57	2.286	72,89	200,88	61,06	95,79	115	37,688
58	2.289	72,27	206,04	61,18	95,70	115	38,493
59	2.292	71,64	211,23	61,28	95,61	115	39,298

Weeks	Body weight (g)	Egg production per hen housed, %	Cumulative egg production per hen housed	Egg weight (g)	Livability (%)	Daily feed intake (g)	Cumulative feed intake (kg)
60	2.295	71,02	216,25	61,39	95,52	115	40,103
61	2.298	70,39	221,40	61,48	95,42	115	40,908
62	2.301	69,77	226,69	61,57	95,33	115	41,713
63	2.304	69,15	231,93	61,65	95,24	115	42,518
64	2.307	68,52	237,05	61,72	95,15	115	43,323
65	2.310	67,90	242,18	61,80	95,06	115	44,128
66	2.313	67,28	247,15	61,86	94,96	115	44,933
67	2.316	66,65	252,05	61,92	94,87	115	45,738
68	2.319	66,03	256,82	61,98	94,78	115	46,543
69	2.322	65,41	261,65	62,04	94,69	115	47,348
70	2.325	64,78	266,48	62,09	94,60	115	48,153
71	2.328	64,16	271,30	62,14	94,50	115	48,958
72	2.331	63,54	276,14	62,19	94,41	115	49,763
73	2.334	62,91	280,75	62,24	94,32	115	50,568
74	2.337	62,29	285,07	62,29	94,23	115	51,373
75	2.340	61,66	288,98	62,33	94,14	115	52,178
76	2.343	61,04	292,46	62,38	94,04	115	52,983
77	2.346	60,42	296,03	62,43	93,95	115	53,788
78	2.349	59,79	299,83	62,48	93,86	115	54,593
79	2.352	59,17	303,83	62,53	93,77	115	55,398
80	2.355	58,55	307,76	62,58	93,68	115	56,203
81	2.358	57,92	311,84	62,64	93,58	115	57,008
82	2.361	57,30	315,91	62,70	93,49	115	57,813
83	2.364	56,68	319,83	62,76	93,40	115	58,618
84	2.367	56,05	323,74	62,83	93,31	115	59,423
85	2.370	55,43	327,57	62,90	93,22	115	60,228
86	2.373	54,81	331,47	62,98	93,12	115	61,033
87	2.376	54,18	335,29	63,06	93,03	115	61,838
88	2.379	53,56	338,38	63,15	92,94	115	62,643
89	2.382	52,93	342,09	63,24	92,85	115	63,448
90	2.385	52,31	345,87	63,35	92,76	115	64,253

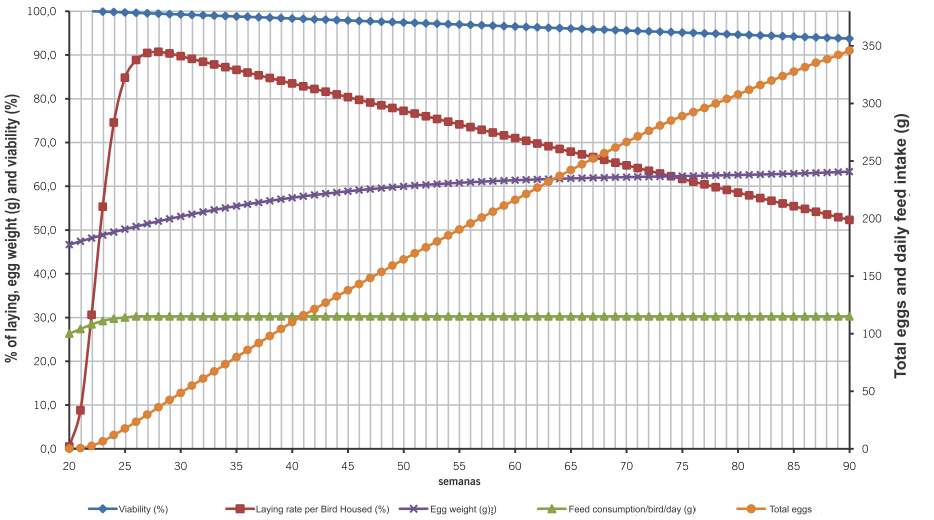


Figure 11. Performance goal curves of Embrapa 051 layers.

TABLE EGGS

Egg collection

The eggs should remain in the nest for the least possible time to prevent their contamination. Therefore, six daily collections are recommended. Egg should be collected in properly cleaned and sanitized plastic trays. After collection, still in the egg room, eggs should be graded according to weight and eggshell appearance. Eggs should be then placed in trays and stored under refrigeration at 8-15°C or immediately transported to retail.

Egg grading

The general standards for the inspection of eggs and egg products are established in Ordinance No. 1 of the Brazilian agency for the inspection of animal products (SIPA) (BRASIL, 1990). Table 11 shows egg grading according to weight.

Table 11. Commercial grading of table eggs according to weight.

Egg grades	Egg weight
Small	45 g - 50 g
Medium	51 g - 55 g
Large	56 g - 60 g
Extra-large	61 g - 65 g
Jumbo	Heavier than 65 g

Production monitoring

It is advisable to record everything that occurs with the flock, that is, feed intake, mortality, egg production and its variations (cracked, deformed eggs, etc.), bird weight by sampling, among others. This information is important to take corrective and health measures, including flock culling. Table 12 provides a record sheet template to register egg production of a layer flock.

Table 12. Monitoring record of a layer flock.

Natural egg farm		Flock:	Source:		Day of hatch:
Number of birds		Beginning of lay: weeks		Culling: weeks	
Weeks	Number of eggs	Cracked, deformed eggs	Feed offer	Mortality	Observations
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Natural egg farm		Flock:	Source:	Day of hatch:	
Number of birds		Beginning of lay: weeks		Culling: weeks	
Weeks	Number of eggs	Cracked, deformed eggs	Feed offer	Mortality	Observations
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
...					
90					

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Instrução Normativa SDA nº 10, de 11 de abril de 2013 - Definir o programa de gestão de risco diferenciado, baseado em vigilância epidemiológica e adoção de vacinas, para os estabelecimentos avícolas considerados de maior susceptibilidade à introdução e disseminação de agentes patogênicos no plantel avícola nacional e para estabelecimentos avícolas que exerçam atividades que necessitam de maior rigor sanitário.

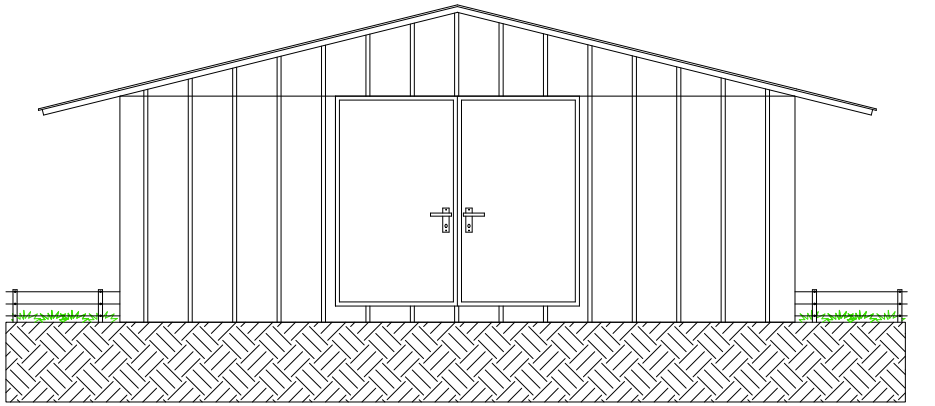
Instrução Normativa SDA nº 8, de 17 de fevereiro de 2017 - Altera a Instrução Normativa nº 10, de 11 de abril de 2013.

Instrução Normativa SDA nº 18, de 25 de maio de 2017 - Procedimentos para Registro, Fiscalização e Controle de Estabelecimentos Avícolas de Reprodução, comerciais e de Ensino ou Pesquisa.

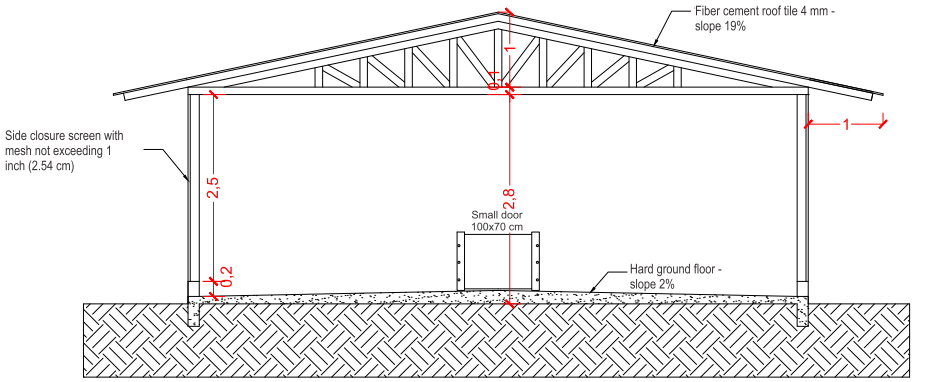
ANNEXES

Annex 1 – Design of an alternative egg production system

Sketch of a shed for layers with access to a paddock.

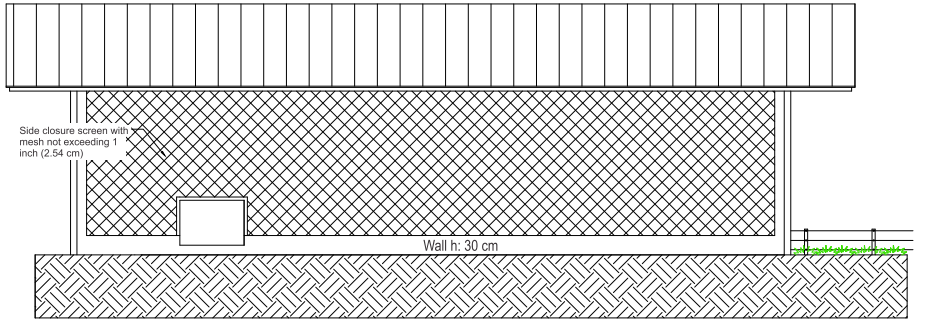


Front facade
Without scale



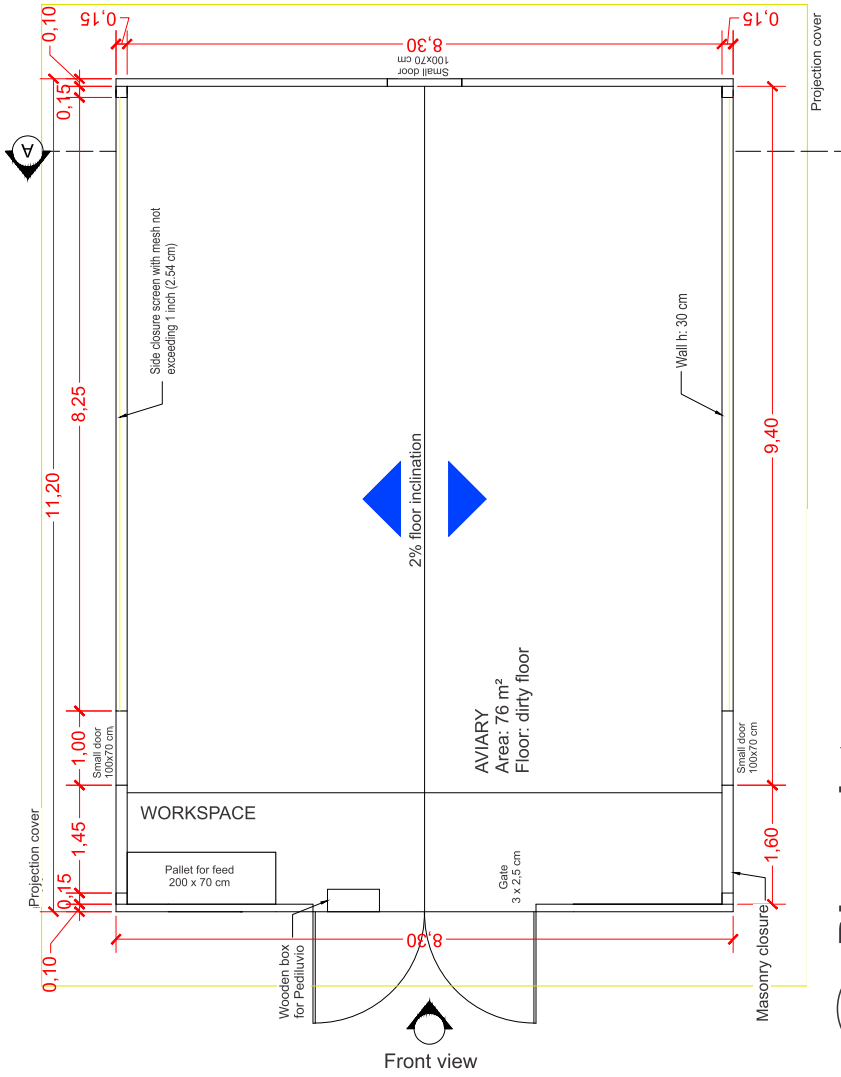
Court AA

Without scale



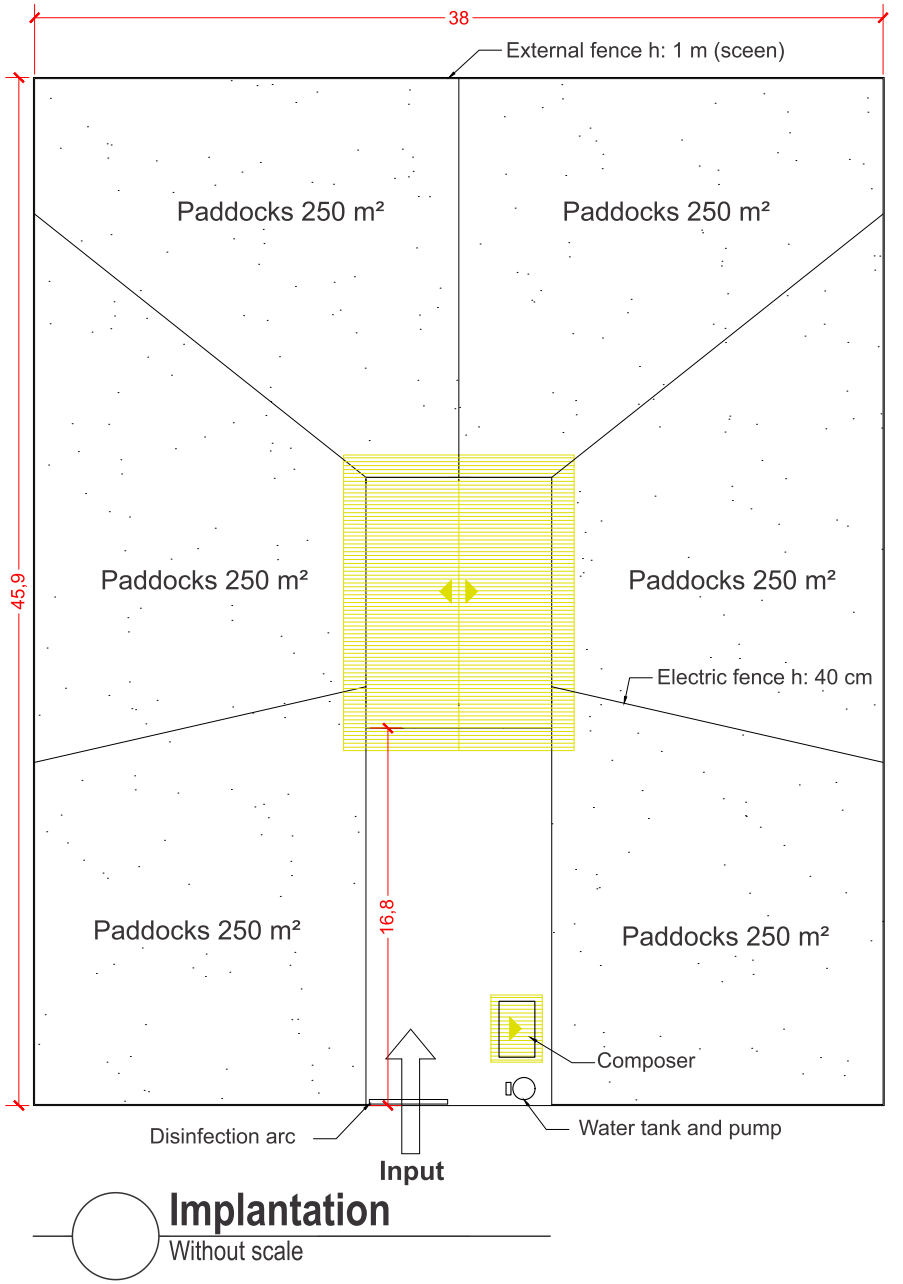
Side facade

Without scale



Blue print

Without scale



Implantation
Without scale

Annex 2 - Design for 500 hens

Required area	Unit	Quantity
Facilities		
Shed	m²	80
Paddocks	m²	1.500
Paddock screen	m²	201,4
Polls for paddock fences	Unit	68
Equipment		
Tube feeder	Unit	25
Bell drinker	Unit	12
Nests*	Places	100
500-L water tank	Unit	1
Corn grinder**	Unit	1
Feed mixer **	Unit	1
Inputs		
90-d-old pullets	Unit	500
Pre-laying feed, up to 20 weeks	Kg	1.975
Laying feed 21 - 45 weeks	Kg	10.542
Laying feed 46 - 80 weeks	Kg	15.071
Wood shavings	m^3	8
Egg package	Unit	13.125
Vaccines ***		
Revenue		
Eggs	Dozen	13.125
Hens at depopulation	Unit	460
Litter	m^3	8

* When using tilted nests, refer to Embrapa's folder "Ninho adaptados para poedeiras", available at: https://www.embrapa.br/busca-de-publicacoes/-/publicacao/1049374/ninho-adaptado-para-galinhas-poedeiras.
** When the feed is mixed on the farm.
*** The vaccination program should be established by the local veterinarian.

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PÁTRIA AMADA
BRASIL
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