# Climate Resilient Chicken Production

For Project TA 6914-CAM: Climate-Resilient Farming and Supply Chain Development to Support Covid-19 Recovery for Smallholder Poultry and Maize Farmers.

prepared in collaboration with Farmers and Nature Net, Cambodia
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## Foreword Poultry Manual

Cambodia is on track to reach middle income status by 2030. A country's protein consumption correlates with increasing GDP, and Cambodia's will follow global trends.  Chicken consumption, in particular, is predicted to grow significantly. About 90% of the 115 million chickens sold in Cambodia's (urban) markets are white broilers and yellow broilers, raised on around 800 commercial farms. The other 10% are mostly native backyard chickens, most of the Morn Srea type, produced by roughly 70,000 smallholder farmers. On average, each small farm raises about 75 chickens per flock per cycle, totalling around 15 million chickens per year.

The bulk of the growth in chicken production is expected to come from commercial broiler farms. However, small-scale backyard farming still has a role, serving a niche market for slower-growing, high-quality chickens. It also provides small farmers with an additional income source, without requiring much labour, and with relatively low investment. Breeding programs are working to develop improved native chicken breeds that grow faster and are more resistant to disease.

Backyard chicken farming remains financially attractive to small farmers due to market demand and higher prices. However, these chickens take between 4-6 months to grow, much longer than the faster-growing commercial broilers. With climate change, rising temperatures are affecting chicken growth and health, making backyard chickens more prone to disease. Farmers can adapt by focusing on giving chicks a strong start, using more commercial feeds to build resistance, use improved housing with more shade and ventilation, and provide cool drinking water to help chickens cope with heat.

To support farmers' climate resilience, SNV and the Farmer Nature Network (FNN) are training 2,000 female and male backyard chicken producers on improving production and adapting to a warming climate. AERES, an international poultry expertise centre, provides technical support. The project is funded by the Asian Development Bank, in coordination with DeHeus-TMH Feeds.

We hope this manual on climate resilient small scale chicken production will be useful to farm leaders and extension staff.

SNV - Phnom Penh – October 2024

## Contents

# 1. First weeks; very important!

When a chick hatches it is still very vulnerable. The immune system to defend itself against diseases is not properly developed yet, the digestive system also needs to develop and the chick cannot maintain its own body temperature for the first week.

Only during the first weeks, the digestive system develops as well as the immune system, to fight off diseases and to ensure vaccines to be effective. After those first weeks, this does not develop anymore. So, if the chicks are well managed during the first weeks, then the chance of problems later life in life is reduced and on the contrary, when the chicks are not well managed during the first week, the chance of problems later life in life is increased. In other words the management during the first weeks is very very important.

## 1.1 What do those chicks want during the first weeks?

### 1.1.1 Hygiene

Freshly hatched chicks often do not even weigh 40 grammes and their immune system to defend themselves against diseases is not yet developed, so they are very vulnerable. Because of this, make sure their environment (housing, feeders, drinkers, heat source) is as clean as possible and make sure whatever enters their environment is also clean. See also Chapter 2 Biosecurity

### 1.1.2 Water

Water quality and -temperature is even more important than feed quality. The water is the drinkers should be so good that the farmer would not hesitate to drink it her/himself, which implies that not only you need good quality water, but also clean drinkers.

The water may have been good quality when it was used to fill this drinker, but you see that the drinker is not clean. If you gently feel the walls of this drinker, you will feel a somewhat slimy layer, which is filled with bacteria hiding there. At least once a day during the first weeks, the entire drinker must be carefully cleaned.

Surely the drinkers must be easy accessible for the chicks.

**All chickens in both pictures are 7 weeks old. They are the same breed, hatched in the same region in the same month. The chickens on the left are well managed, are healthy and have grown well. The chicken on the right were poorly managed and did not grow. As these birds are already 7 weeks old, even first class feed and management from now on, will not make them develop better, as the digestive system and the immune system develop in the first weeks only!**

Also the drinking water temperature is important. During the first days, chicks like a warm environment of about 32 – 37 °C, so also the water will quickly assume that temperature. However, when the water is equally hot, the chicks will drink less water than needed. So several times a day the water needs to be refreshed, as chicks like water of about 24°C.

### 1.1.3 Feed

Especially the first weeks it is important to provide a quality starter feed. It is expensive feed, but fortunately chicks do not eat so much during the first weeks. During the first 5 weeks chicken may have eaten about 700-800 g each; a bag of 30 kg could feed some 35 – 45 chicks during the first 5 weeks. Shallow trays may be used as feeder, but also spread some paper on the litter on the floor and feed small amount several times a day on this as well. Chicks like eating of the floor and it is important to get the chicks to eat as soon as possible. After a few days, just feed on the trays or feeders for chicks as the feed on the floor gets contaminated when the chicks get older.

## 1.2 Housing

During the first week, chicks just need about ½ $m^2$ /50 chicks. In the second week that space needs to be doubled. Apart from that space, they need a sold floor with e.g. rice husks with paper on top. Of course, the housing for the chicks must be clean and disinfected! See also Chapter 2: Housing

### 1.2.1 Temperature

During the first week, the chickens cannot maintain their proper body temperature. The environment needs to be about 32 – 37 °C and especially the floor should be at least 28°C; feel with your hand-palm, it should not feel somewhat cold. If the chick's temperature drops, then they will move less and eat less, which hinder the essential development in these first weeks.

Especially night and around sunrise it might be too cold for the chicks and when a heater is not available, you should consider placing the chicks in a clean (!) box during the night.

The picture below shows a brooder with a lamp as a heat source. The chicks can move closer or further away from the heat source, as they like. The water and feed is kept at some distance from the heat source, to prevent it becoming too hot. Even if the heat source is switched off, the chicks still like to rest under the hood as it provided them a sense of safety it appears.

### 1.2.2 Light

Chickens only eat when there is enough light and since it is very important for chicks to eat plenty during the first two weeks, providing light also during the night will give them plenty opportunity to eat, drink and properly develop their bodies. After these first weeks, they don't need light at night anymore, although if you want your chicken to grow as fast as possible, you make sure there are just 4 hours darkness for the chicks. Preferably from 6 pm to 10pm (see also Chapter 5 on heat stress).

### 1.2.3 Stress free

All chickens, but certainly chicks, are easily stressed, leading to development disorders and extra susceptibility to diseases. Stress comes from, light (too bright or changes), noise, handling, sudden changes, chances in feed, lack of shelter, exposure to diseases, etc.

*Chicks confined with hen. The hen can keep chicks warm, but environment is not hygienic; plenty exposure to pathogens, see e.g. very dirty drinker.*

*Chicks are separated from the hen. The hen cannot keep chicks warm. More hygienic, though the hen may carry pathogens and still infect the chicks.*

### 1.2.4 Staying with the hen which hatched them?

When the hatching eggs are not incubated artificially, the chicks may stay the first weeks with the hen, instead of being separated from the hen. Both systems have advantages and disadvantages.

When the chicks stay with the hen, the hen will provide some shelter and keep the chicks warm. However, when the chicks are close to adult poultry there is also a health risk, since the chicks have no defence yet against the disease casing agents (pathogens) to which the adult birds are resistant. When the hens wanders around with the chicks, she will show the chicks where to find feed, but also expose them to more pathogens and predators. To reduce these risks, chicks should stay on one, clean, spot as much as possible.

Separating the chicks from the hen and placing them in a suitable clean environment usually gives better less mortality, though requires more attention from the farmer.

Do realize that preventing diseases is much better than curing diseases.

- For quite a few poultry diseases there is hardly effective medication available.
- Even if poultry gets better from a disease, it will have suffered, so performance will be reduced also

# 2 Biosecurity

Biosecurity simply means: **'what do we have to do to keep diseases from entering a poultry farm'.** Biosecurity measures are meant to prevent disease causing agents, called pathogens, like bacteria, viruses, fungi and parasites to enter a flock, to multiply on farm and to survive. Hygiene and proper vaccination will be most important aspects. Surely, not all diseases can be prevented by good hygiene and vaccination on a farm and e.g. lack of minerals or vitamins in the feed can also cause diseases, but the risk of infectious diseases can be reduced significantly by Biosecurity measures.

## 2.1 Preventing pathogens to survive on a farm

During a production period inevitably some pathogens will be in the farm. If the numbers are limited and the poultry is used to those, it will not lead to extensive disease issues. But, if a new flock arrives, which is not yet used to these pathogens and is still very vulnerable to diseases, like young chicks, these pathogens may lead to disease issues. For that reason everything which was in contact with poultry has to be cleaned and disinfected before it gets in contact with a new flock again. This includes the poultry unit and equipment (floor, walls, perches, roof, drinkers, feeders, brooding equipment like heater(s), feed plates, feed scoops, ...)

Cleaning and disinfection are two separate actions! Disinfectants are usually less effective in a dirty environment, so the items first have to be cleaned (water, soap) and only after that disinfectants can be used.

## 2.2 Preventing pathogens to enter a farm

The farmer always has to be aware who or what gets in contact with the birds and whether or not this is clean, without pathogens, because there are many ways pathogens may enter a farm, e.g.

• with infected other poultry, other (wild) birds or even other animals (inc. dogs, cats, rodents and insects)

o Therefore, keep your birds away from other animals, make sure pets cannot be in the vicinity of your chickens. If you have various chickens of various ages, make sure to keep them separated. Also realize that when chickens can scavenge outside the poultry unit, they are easily infected, e.g. by wild bird droppings.

o Rodents not only cause damage and eat expensive feed, but they may also contaminate it and may spread as many as 35 different poultry diseases. So make sure the poultry unit and feed and water is as rodent proof as possible. Do realize that rodent like rubbish and like to hide, so keep you farm as clean as possible, with just low vegetation nearby.

• with equipment or tools or other items brought to the farm

o Therefore, whatever is getting in contact with the birds, do assess the risk and if not sure, wash it!

• with droppings, dirt from a previous or other flock

o Therefore, make sure that dirt and droppings are away from the poultry

• with water and feed, as well as the air.

o Therefore, make sure the water is clean, but also clean the drinker frequently (especially the inside).

• with people (!), important, as quite a few outbreaks of infectious poultry diseases are caused by people.

o This implies that the farmer always has to be aware who or what gets in contact with the birds and whether or not this is clean, without pathogens.

- Make sure your hands are clean, every time to enter a poultry unit or get in touch with anything which will get in contact with the chickens (e.g. drinkers, feeders)
- If you have to enter a poultry unit, then wear different footwear, even if you have to enter for just a few seconds. Near the threshold of the poultry unit you may hang (off the floor) footwear, which you use only (!) in the poultry unit, so you should change at the threshold. When you leave the poultry unit, even for a brief moment, you change your footwear again. Once you get accustomed to this routine and practise it wisely and consistently, it is more effective than using a foot-bath, which is more difficult and expensive to maintain effective.

• with air

o Unfortunately, pathogens of some very threatening poultry diseases like New Castle Disease and Avian Influenza, travel by air and since chickens need also plenty air for ventilation, the risk is always there. You can reduce the risk by placing the poultry unit far away from other poultry units and consider common wind directions so that air from other poultry units will not enter your poultry unit.

## 2.3 Preventing birds to infect each other

When one or a few birds in a flock appear to be sick, a common reaction of the farmer is to place these in a separate corner of the poultry unit. Do realize that even when separated, they may still infect the other birds. In fact most chickens get sick because other chickens from that flock are sick. The sick birds may survive, but performance of these chickens is usually disappointing and besides during their disease they will form a big risk of infecting other. Because of this, it is often best to cull these chickens and dispose of them properly.

### 2.3.1 Disposing of dead birds

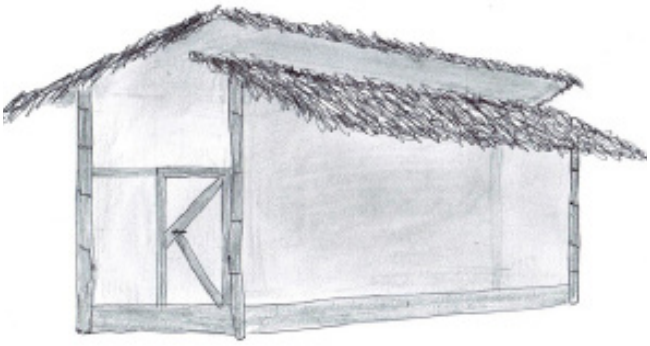
Even if birds have died, they may still be a health risk for other birds, especially if remains of these dead birds are spread by dead-animals eaters like crows, hawks, kites, rats, cats, dogs and others. It is therefore important to dispose of the dead birds properly by incinerating or burying them.

## 3 Housing

Suitable housing will:

- Provide a comfortable stress-free environment for the chickens
- Protect the chickens against harsh weather conditions (rain, hot/cold weather)
- Protect the chickens against predators and, partly, against pathogens like bacteria, fungi, viruses
- Facilitate management

*Poultry unit with raised slatted floor*



*Poultry unit with sold floor and open roof to ensure maximum airflow*

## *Cages for young chicks*

## 3.1 What do chickens want?

### 3.1.1 Space

Chickens want enough space, during the first days 1m2 is sufficient for 100 chicks, but after a week these chicks will need already 2 $m^2$. After that, up to point of marketing, you can keep no more than 6 birds per $m^2$ when there is a slatted floor Therefore, a house or cage of e.g. 1.5 m wide x 5.5 m long is enough for 50 chickens and a house or cage of e.g. 2 m wide x 8.3 m is enough for 100 chickens. If chickens have a solid floor, then after 2 weeks you can keep no more than 4 birds/$m^2$. So a house of e.g. 2 m wide and 6.3 m long should be sufficient for 50 birds, or e.g. a house of 3 m wide and 8.3 m long should be enough for 100 chicks.

### 3.1.2 Feeders and drinkers

Feeders should be easily accessible for the birds, but not too easy, as they may spill feed as well. During the first two weeks the focus should be on easy eating, but later feed spilling has to be avoided, so choose a feeder which minimises spilling and if possible place it off the floor, on some bricks e.g.

The same applies for drinkers. They must have easy to access, but spilling must be avoided. Spilled water, especially on a solid floor creates a dirty environment, ideal for bacteria and fungi to develop. So also here, after the first weeks, place the drinker at some height, so that they can easily drink but not spoil or contaminate the water.

### 3.1.3 Perches

By nature, chickens do not like to rest and sleep on the floor, but they prefer to rest off the floor on branches or perches. To avoid stress, it will be good to provide perches.

*The picture shows hybrid layers with perches for which you need about 15 cm sitting space per layer.*

*Local chickens are smaller and therefore 13 – 14 cm per birds is sufficient, which mean that if you have 50 chicken you need about 6.5 – 7 m of perches. Bamboo sticks, which are relative easy to clean, with a diameter of about 3 cm are very suitable.*

### 3.1.4 Good climate

To protect the chicken from rain, there should be a water tight roof, overhanging the sides, so that also in windy conditions the chickens do not get wet when it is raining. This will also avoid sunlight entering the unit.

On hot days, the chicks should not be exposed to the sun, for which the overhanging roof will useful and an East-West orientation of the poultry unit will help also (see also 3.1.5 Light)

To further avoid the chicks becoming too hot, a place in the shade is important, next to the quality of the roof. A roof made of corrugated iron sheets, may be durable, but radiates plenty heat to the chickens in the unit, especially if the roof is low. A thatched roof is much more comfortable for the chicks as it is insulating, which implies that the chicks stay relative cool during the day, but also relative warm during cold night. A disadvantage is that it needs to be replaced frequently as it can hardly be cleaned and disinfected and there is a risk that it attracts harmful rodents.

Ventilation is also important and especially a breeze will help chicken to get rid of access heat on hot days. For that reason, the unit should be as open as possible. The sides can be covered with wire mesh. The smaller the openings in the wire mesh, the less likely it is that rodents can enter the unit, but very small openings in wire mesh are easily covered in dust and thereby blocking ventilation. Openings of 1.5 cm to 2 cm are suitable. The floor can also be open to allow ventilation and to reduce the occurrence of chickens getting in contact with their droppings. A floor made of bamboo slats is suitable.

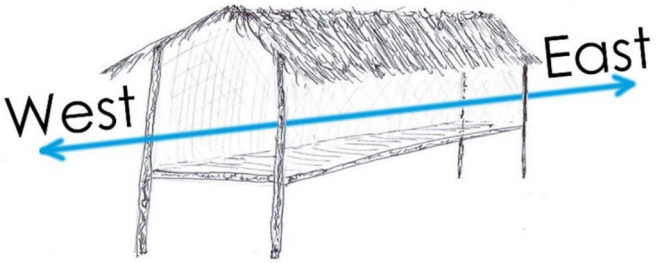
*Chickens in a poultry units on bamboo slats and perches*

*Chickens on relative wide bamboo slats, for maximum air-flow. A net is placed on the bamboo slats, to prevent chicks from falling through the slats.*

*A brooding area created on top of a slatted floor. On the slatted floor a course net and a fine net is placed, on top of which rice husks are placed. After about two weeks the rice husks and the fine net is removed.*

### 3.1.5 Light

As mentioned before, chicks need some light to eat and drink, but direct sunlight into the poultry unit is to be avoided. Direct sunlight from which they cannot escape by finding a darker place in that poultry unit, may lead to a lot of stress, affecting performance of the chickens and it may even lead to severe pecking, causing chicken to die (cannibalism).




*You may be able to avoid the low morning- and afternoon sun entering the unit excessively by placing narrower sides of the unit in an East-West orientation, so that the morning and evening sun will enter the unit via a relative small opening only.*

## 3.2 What does the farmer want?

Of course, farmers want a poultry unit in which their poultry can grow fast without problems, but in addition to that farmers also want a poultry unit which is low costs, easy to manage, to clean and to disinfect.

Instead of investing in a poultry unit with a solid floor, a 'cage' as shown in the beginning of this chapter is cheaper, and if for a small flock of about 50 chicks, a relative small cage, which may even be portable (with a few strong people) is possible.

As for equipment, the farmer wants feeders and drinkers which are easy to manage and easy to clean. Especially the drinkers are to cleaned daily!

# 4. Artificial Incubation

Most chickens, especially rural breeds, can incubate their eggs very well and take care of the well-being of the chicks as well. Still, there are also reasons why artificial incubation is preferred:

• Once a hen starts brooding, the egg production stops, whereas when her eggs are collected daily, the hen's hatching egg production continues

• The maximum number of eggs to be hatched on one day is limited to the number of eggs in one clutch, may be only 10 – 12. When you artificially incubate the hatching eggs, it depends on the capacity of the incubator; could be 50, 100, 200, 500, 5000, ...

• After the hatching eggs is laid, the eggs have to cool down to less than 27°C (preferably less than 25°C), before incubation starts. The hen cannot do that.

• To prevent freshly hatched chick getting into contact with pathogens carried by older poultry

• To be able to provide immediately the brooding conditions required for optimum chick development

## 4.1 Hatching egg collection

### 4.1.1 Keep the area where hatching egg are laid clean!

Hatching eggs should be laid in a clean environment. When the environment where the hatching egg is laid is dirty, dirty, i.e. has a lot of bacteria and mould, these may enter the egg while the egg is cooling down from 41°C to the temperature of the environment; thereby sucking in air (and possibly bacteria and mould) from its environment. As a result, these bacteria and mould will contaminate the developing embryo, causing it to die during incubation or causing the chick to develop poorly after hatching.

There is no easy way to clean the eggs. Wiping it with a dry or, worse even, wet cloth, will only spread the contamination.

### 4.1.2 Storing hatching eggs

The best incubation results are achieved when the hatching eggs are stored 2 – 3 days before incubation starts, however, good results can also be realised when eggs are stored much longer depending on storage conditions and management. Most important for tropical conditions is to realize that hatching eggs have to cool down to and stored at a temperature less than 27°C (preferably even less than 25°C). Below this critical temperature the embryo in the egg enters a dormant phase, in which it can survive several days. If the temperature is higher this dormant phase is not realised and some development will take place during storage, resulting in poorer hatchability of the sored eggs and poorer quality chicks.

## 4.2 Incubation

An incubator is basically a box ( or a set of boxes) in which:

• a certain temperature and relative humidity can be maintained everywhere in the box

• some fresh air (with O2) can enter the incubator and used air (with CO2) can be exhausted

• the eggs can turn frequently over an angle of 90°

• the embryos in the eggs can develop in a clean environment

• the chicks can hatch, dry and rest after hatching in a clean healthy environment

*An incubator with a capacity of some 176 hatching eggs*

### 4.2.1 Temperature and humidity

Small scale incubators in Cambodia usually have eggs inside with various stages of development; some eggs may have entered the incubator a day ago, while other eggs have been in there during e.g. 8 days and perhaps even other eggs entered before or after that. Because of that it is not possible to set the temperature in the incubator according the requirement of the stage of development (freshly placed eggs would require a slightly higher temperature than the eggs placed in the incubator before that). The ideal temperature for embryo development is 37.8°C (100°F). Hatching eggs are more sensitive to too high temperatures as compared to too low temperatures, so therefore it is recommended to set the thermostat of incubator at 37.5°C. The air is circulated inside the incubator by means of a ventilator to ensure that this ideal temperature is maintained everywhere in the incubator.

However, depending on the quality of the incubator, the temperature on various points inside the incubator may vary more or less.

The required relative humidity depends on a lot of factors. Too high relative humidity prevents the air cell in the eggs to grow sufficiently and the chick will contain too much water; the chick will have difficulty hatching. Too low relative humidity will cause the chick to dehydrate too much and become weak. Ideally the relative humidity should cause the weight of the eggs to reduced 12% after 18 days of incubation. As mentioned, there are plenty factors to influence this, but quite common is to set the relative humidity at 55 – 60%.

The incubator will need water from outside to keep the desired humidity. That water has to be clean, as well of the water lines and container to avoid contaminating the hatching eggs.

### 4.2.2 Air exchange

A small opening in the incubator (just a few cm2) is usually enough to ensure enough gas exchange. When the opening is too big and the climate (°C and RH%) inside and outside the incubator is significant, most incubators may not be able to maintain the ideal climate inside the incubator.

### 4.2.3 Turning

Several times a day (usually every hour) the eggs are turning over 90° to prevent the embryo to stick to the wall, to ensure sufficient flow of nutrients inside the hatching egg (especially first days) and to ensure that airflow reaches all sides of the egg.

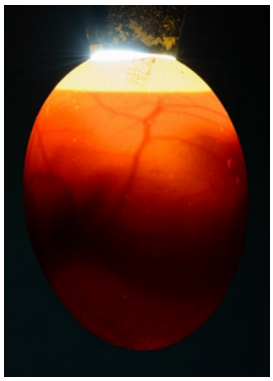
### 4.2.4 Clean environment

Hatching eggs with growing embryos in a nice warm environment are attractive to all kinds of bacteria and mould. Dirt inside an incubator, especially from poultry origin, keeps these bacteria and mould alive and these may even grow inside the incubator.

*When egg trays are removed, they are to be thoroughly cleaned before storage or re-use, unlike this egg tray*

### 4.2.5 Hatching

After about two weeks of incubation you can candle the eggs (in a dark environment plate the blunt side of the egg on the flashlight of your phone e.g.). The eggs holding a live embryo will be dark inside and blood veins are shows. Infertile eggs are clear.



**To the left an egg with dark content and showing blood veins.**

**A life embryo inside**

**To the right a clear egg, no developing embryo can be seen. Either the egg was not fertilised or the embryo died within the first few days**

Infertile eggs or eggs with a dead embryo inside (no blood veins visible) should be taken out; they can only cause trouble.

Ideally the eggs with the live embryo should be replaced from a tray to a basket and placed in another incubator. Professional hatcheries always use two kinds of incubator; Setters, to incubate for the first 18 days and Hatchers for the last 3 days, in which the chickens hatch.

**The incubator on the left is used for the first 18 days only; a Setter (eggs are in trays and turned)**

**The incubator on the left is used for the last 3 days only; a Hatcher (eggs are in baskets and no turning)**

During the first 18 days of incubation, the incubator does not get contaminated, provided that the none of the hatching eggs 'explodes' during incubation as a result of gas produced by bacteria inside the egg (when eggs are laid in a dirty environment this is a real risk). However, when the chicks hatch, the incubator gets contaminated severely by initial droppings from the chicks, possibly some blood from the egg-shells and plenty fluff released from the down feathers of the chicks. Because of this, after every hatch, the incubator is to be washed thoroughly before new hatching eggs are placed.

Most farmers in Cambodia who incubate eggs use just one incubator allow the chicks to hatch in the same incubator, which implies that the incubator can only be cleaned when it is not in use for some time.

**Hatched chicks walk on the floor of the incubator. Although the incubator is very dirty, it cannot be cleaned as for that purpose the incubator has to be switched off and emptied, but other the other eggs in the incubator may still need several days of incubation, so the incubator cannot be switched off**

# 5 Feed

The best feed for chickens consists of well-balanced proteins, energy, vitamins, minerals, trace-elements and others, in total more than 36 nutrients in appropriate concentrations and balance. All these nutrients in the correct amounts should be available in commercial poultry feed to be conditional for a problem-free development of the chicken. Poor quality feed will lead to reduced performance and may also lead to increased susceptibility to diseases.

However, quality feed is always expensive and therefore farmers are tempted to make feed with some cheaper locally available feed stuffs, often leading to sub-standard feed quality, since for farmers it is complicated and expensive to acquire all ingredients to ensure those 36 nutrients in the correct quantities.

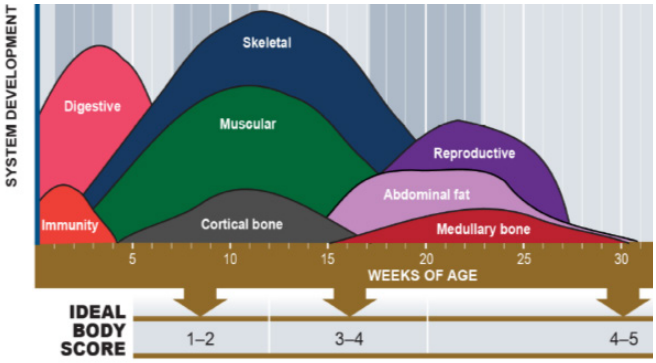
If the provided feed is not well balanced, but chickens can scavenge freely in an area with plenty feed stuffs for poultry, these birds may be able to find feed-stuffs, like insects with important proteins, and/ or seeds with important minerals and/or vitamins which are not available in the provided feed and thereby improving their feed intake. Although of course, free scavenging birds are also an easy prey for predators and diseases. If birds can only eat the feed provided by the farmer and that feed is not completely balanced, performance will be affected.

## 5.1 How much to feed?

Since feed is expensive and farmers want to avoid the chicken becoming fat, many farmers are inclined to feed the birds a limited amount of feed. Consider:

• Chickens need feed to grow. The more you feed the chickens, the faster they grow, so the sooner they will reach the marketing weight. Also, the shorter the time they need to reach the marketing weight the less feed they will have consumed in total. E.g. if a chicken is fed on average 50 g/day (in the first weeks less and in the last weeks more) it may take 5 months to get to be 1.5 kg, but if the chicken is fed 60 g/day, it may take just 4 month to reach 1.5 kg. In the first case some (50 g/day x 152 days =) 7.6 kg feed is spent, but in the second case just some (60 g/day x 122 days =) 7.3 kg is consumed. Not only is some feed saved per chicken, but also the growing period is reduced by 1 month, which implies that more chickens can be marketed per year. Surely only by weighing and recording the real data for Cambodian farmers raising local chickens can be established.

• During the first month chicken will hardly deposit fat on their body. Instead they will need the feed to develop their immune system, their digestive system and their body. So even though initial commercial starter feed is expensive, make sure this feed is not wasted, but allow the chicks to eat this sufficiently.




The graph shows how the various body components develop depending of the age of the chicken.

Graph from: https://www.hyline.com/

## 5.2 Home-made feed?

Especially the first month, the development of the chickens' body is critical and therefore it is recommended to provide the chickens in that period with quality feed; even if this is expensive, to prevent disappointing production. Also after that first months quality balanced feed is important, but the genetic potential of the local chickens to grow is limited, and the effect of providing a feed which is not completely balanced in nutrients is limited as well. To be clear, this does not mean that you can give the chickens any kind of feed-stuff and expect them to perform well. Also if you are going to prepare feed with cheaper feed stuffs, you must try to create a balanced feed as much as possible.

### 5.2.1 Use commercial feed as a base

You could mix a feed with e.g. rice bran, fish meal, dried azolla and/or maize, but you will miss essential nutrients as these ingredient do not hold all those nutrients. The consequence of lacking some essential nutrients will be that the chickens are hindered in their development and possibly suffer from deficiency disorders. E.g. lack of vitamins and minerals can lead to a range of health problems . You could consider using 30 – 50 % quality commercial feed and 'dilute' is with some local available feed stuff. Also now you will not get a complete quality feed, but all nutrients will be in the feed, be it in smaller, non-balanced quantities. So you cannot expect the same performance as compared to feeding the chickens with complete feed, but the feed will be cheaper.

Above you see a chicken which is likely to suffer from a Vitamin B deficiency as no complete feed was provided for this chicken and/or its mother.

**According to Alabama Cooperative Extension System (https://www.aces.edu/blog/topics/farming/nutrition-for-backyard-chicken-flocks/) rural chickens have the following general nutrient requirements:**

Local available feed stuffs are not abundantly available and farmers sometimes have to go to considerable lengths to obtain them. Often those locally available raw materials are mainly rich in energy and poor in protein (such as broken rice or maize), or can only be added to feed to a limited extent, such as rice bran. Some farmers also start producing their own raw materials such as earthworms, larvae of black soldier flies and azolla.

| Age | Diet Type | Metabolizable Energy (kcal/kg) | Crude Protein (cp) (%) | Calcium (%) | Available Phosphorus (%) |
|---|---|---|---|---|---|
| 0 to 6 weeks | Starter | 2850 to 3000 | 20.0 to 22.0 | 0.85 to 1.00 | 0.40 to 0.45 |
| 6 to 14 weeks | Grower | 2850 to 3000 | 16.0 to 18.0 | 0.80 to 0.95 | 0.35 to 0.42 |
| 14 to 20 weeks | Developer | 2750 to 2850 | 14.0 to 16.0 | 0.75 to 0.92 | 0.30 to 0.38 |

**Which raw materials may be available?**

• Rice Bran (https://www.feedipedia.org/node/750): The nutritional value differs, depending on a.o. fibre content, which may vary from less than 4% to more than 20%. Rice bran with 4-11% fibre has about 14% cp and 5000 kCal. Use up to max. 15% of the diet, because it may become rancid and the crude fibre (cf) may be too high.

• Broken rice (https://www.feedipedia.org/node/748): High in energy (4300 kCal) but low in protein (cp 9%)

• Azolla (https://www.feedipedia.org/node/565): Dried azolla can be max. 10% of the diet, Fresh azolla up to 20%. The fresh azolla should be mixed and supplied instantly, when you store feed with wet azolla, the feed may be spoiled easily. Dried azolla is rich in protein (cp 20%), and low in energy (dried, just about 1000 kCal/ kg )

• Larvae of black soldier flies (https://www.feedipedia.org/node/16388): Dried larvae of black soldier flies are rich in protein (cp 42%), fat (26%), but depending on feed for the larvae) en therefore energy (5000 kCal/kg).

• Earthworm meal (https://www.feedipedia.org/node/665): dried earthworm have a very high protein% (cp 60%) and high energy (3300 kCal/kg) for poultry. Digestibility is also good. Could be added up to 5% for small chicks up to 8% for older chickens.

• Okara, left-over from Tofu production: Okara that is firmly packed consists of 3.5 to 4.0% protein and 76 to 80% moisture. When moisture free, the gritty okara contains 8 to 15% fats, 12 to 14.5% crude fibre and 24% protein, and contains 17% of the protein from the source soybeans.

### 5.2.2 Make your own complete feed

If you don't want to buy a complete feed at all, you might consider making a complete feed, by buying several suitable ingredients. That indeed could reduce the cost of feed, although you will need to buy several ingredients, store, (partially) grind and mix them to get a complete feed. Also, do realize that you cannot prepare the essential mixture of vitamins and minerals, so that needs to be purchased anyhow.

To determine which ingredients need to be bought, there is a free app (Feed access )available to make a least cost quality feed based on locally available feed stuffs.

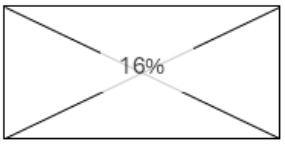
### 5.2.3 Option 1: Use the simple Pearson square ration formulation method

This can be used when you have just two ingredients, like Maize and Soya Bean Meal (SBM) and you want to know how much to use from each ingredient to get the proper protein level in the mixture. For that you need to know the protein level requirement of growing local chickens (about 16%) and the protein levels of both maize and SBM.

Maize has a crude protein (cp) level of about 9.7% in Asia according to Feedipedia (https://www.feedipedia.org/) . The crude protein level of SBM however, fluctuates as there also different types of SBM. SBM type 50 has about 55% cp, SBM type 48 has about 53% cp, SBM type 44-46 has about 50% cp and SBM type 'high oil' has about 47% cp, so it will be good to explore which SBM is available. Let us assume we have SBM with 50% cp and for the maize we assume 10%cp

In a Pearson square it work out like this:

SBM 50% cp — 6 parts SBM (difference 16 and 10)




Maize 10% cp — 34 parts Maize (difference 16 and 50)

In total we have now (6+34=) 40 parts. The portion of SBM will be 6 out of 40, which is (6/40 *100%=) 15% maize and the portion of maize will be 34 out of 40, which is (34/40*100%=) 85%. So now if you want to prepare a bag of 30 kg feed, you need (15% of 30kg=) 4.5 kg SBW and (85% of 30kg=) 25.5 kg maize.

The result is that the 30 kg of mixture will have a crude protein content of 16%, as required by the chickens. However, do not expect this to be a balanced feed! This feed does meet the crude protein requirement, but is not yet balanced in the requirement of all other nutrients.

### 5.2.4 Option 2: Use the Feed access App

The free Feed access app is an online tool https://www.feedaccess.com/en.html to provide a recipe to make a least cost quality complete balanced feed based on locally available feed stuffs.

To make use of the app, you first go to the website, where you'll find a button to ACCESS THE APPLICATION , after which you have to register to the app or connect to the app when you are registered already.

User manual, also to be found online (https://appli.feedaccess.com/sos/en/)

## 5.3 Water!

Water is the most important, but most neglected nutrient in poultry nutrition. Even if chickens cannot drink for a short time their development will be affected, so quality drinking water must be available at all times.

Already mentioned before, the water must be clean, but also the drinkers must be clean to avoid the water getting contaminated by the drinkers.

1 Feedipedia is an open access information system on animal feed resources that provides information on nature, occurrence, chemical composition, nutritional value and safe use of nearly 1,400 worldwide livestock feeds. It is accessible in Khmer as well

The higher the temperature, the more chicken need to drink, so on hot days, they need to drink plenty, but on a hot day, also the water in the drinker will become hot quickly, and when the water is warmer than 30°C the chickens drink less as they should. It is therefore important to provide fresh, cool water several times a day and make sure that the drinkers are also cleaned frequently.

# 6 Heat stress

During the first days after hatching chickens, want an environmental temperature of about 32° - 37°C, but that desired temperature gradually lowers and after a few weeks they prefer a temperature of just 18° - 24°C to perform optimally. However, it is often much hotter in Cambodia, which affects feed consumption and weight gain of the chickens. Besides, it give stress to the birds, which makes them more vulnerable to health issues. It is not just the temperature, but especially high temperature in combination with high humidity is problematic. Fortunately, chickens can get used to hot conditions somewhat and with proper management the negative effects of hot weather can be reduced.

## 6.1 Heat loss for chickens

To get rid of excess body heat, when it is not too hot, chickens radiate heat from their body and try to find a cool spot to lie down and allow the colder surface to cool the body.

*When people threaten to overheat, they start sweating, which moisture will evaporate from the skin and this evaporation takes energy (heat) from the skin and thereby cooling the person. Chickens however cannot sweat, but by rapid respiration water from the lungs is evaporating, with the same cooling effect. Above 25°C this quickly becomes the major way of chickens to cool down.*

## 6.2 Reducing heat stress

### 6.2.1 Reduce exposed temperature

Surely it is not possible to reduce the ambient temperature, but you may be able to make sure it is not getting too hot in the poultry unit. Direct sunlight inside the poultry unit should be avoided of course. Corrugated Iron sheets for the roof are easy to fix and will be quite durable, but they also radiate plenty heat from the sun to the chickens inside the unit, especially when the space between the roof and the chickens is limited. To overcome this, you could consider insulating (the inside of) the roof or use a thatched roof. Do realize that a thatched roof may also attract rodents and birds, which involved an extra risk of diseases.

*This farmer in Vietnam has plants growing on her roof. The green vegetation will absorb plenty heat from the sun, making the environment for the chicken cooler. Extra care is required to prevent diseases entering the poultry unit, as these plant also attract rodents and birds.*

### 6.2.2 Feed at cooler times of the day

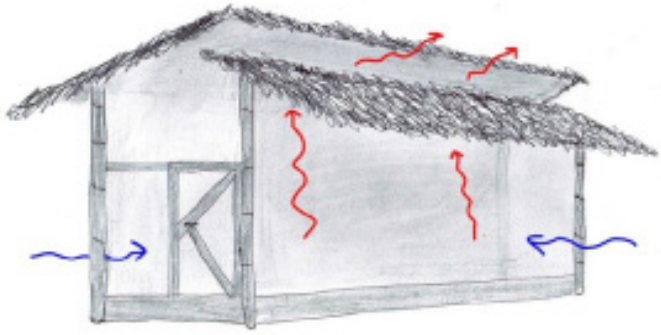
The coldest moment of the day is at sunrise and the hottest time of day is the afternoon. Even if the temperature drops a little in the afternoon, it may still feel hot, because usually then the humidity rises and it is especially the combination of high temperature and humidity which makes it feel hot.

When chicks are eating the feed needs to digest, which process warms the body, so chickens eat less during these warm period. Even early evening it may still feel hot, due to the increased humidity, but when you switch the light on at 10PM and leave it on till sunrise, then chickens have plenty opportunity to eat during the cooler times of the day.

### 6.2.3 Ensure proper ventilation

Also air movement around the chicken will help it to cool down. Because of this, make sure the chickens unit allows plenty ventilation and place it at a place where there can be plenty air movement. Vegetation like small trees or bushes near the house will block free air movement and besides, attract wild animals which you don't want near your poultry unit.

An open slatted floor will contribute to ample ventilation and besides minimises chickens getting in contact with their droppings.

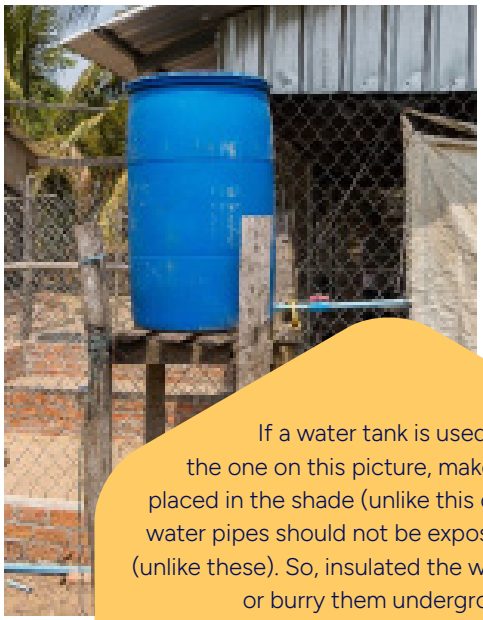


*The sketch shows a Poultry unit with an open ridge (though there is wire-mesh to prevent wild birds to enter). The red arrows show the hotter air rising in the unit and escaping through the open ridge. This air escaping is replaced by fresh(er) air, blue arrows, coming in from the sides. In this way, there is always ventilation.*

### 6.2.4 Make sure chicks have cool water!

Probably the cheapest way to reduce heat stress is to make sure the water is cool. As mentioned in Chapter 5.1, in hot weather, the main way for chickens to cool down is evaporating water from their body by respiration. The chickens therefore have to drink plenty water, sometimes even 5 times as much water as feed. But in hot weather conditions, also the drinking water gets hot and on warm days the water temperature often gets higher than 30°C. Unfortunately, on these hot days the chickens should drink plenty of water, but when the drinking water temperature is over 30°C they drink less! When the drinking water temperature reaches 44°C they don't want to drink at all.

**Not only is it essential to offer cool(er) water to the chicks as they need it to loose excess body heat, but cooler water itself cools the body as well.**



If a water tank is used as the one on this picture, make sure it is placed in the shade (unlike this one). Also the water pipes should not be exposed to the sun (unlike these). So, insulated the water pipes and/ or burry them underground.
In this situation shown, the drinking water will be often warmer that 30°C, because of which chickens will drink less, subsequently eat less and grow less and suffer more from heat stress.
You could further improve the water tank by painting it white as the white colour reflects sunlight.

Another way to cool drinking water is shown in this picture.
The water tank is covered with gunny bags which are kept wet. The water of the wet cover will evaporate, taking energy (heat) from the surface of the water tank and thereby cooling the water a lot.
The effect of cooling depends on air flow around the tank (the more the better) and the ambient humidity (the less moisture in the air, the better the evaporation and therefore the more cooling)
In the picture you may see that the water outlet in not insulated, because of which the cooled water may warm up again before it reaches the chickens. So, do insulate the water pipes!!

## 7 Disease causing agents

There are different causes of diseases in animals:

- Bacteria
- Virus
- Parasites
- Fungi
- Non-infectious diseases

| Virus | Bacteria |
|---|---|
| No living organism, just some DNA or RNA | A living organism |
| Viruses need cells of a host to g¬row and reproduce and cannot grow outside cells | Bacteria can grow and multiply by themselves, also in the environment |
| Viruses are so small that you can't see them with a normal microscope | Bacteria are giant compared to viruses |
| Viral infections are systemic (the whole body is involved and gets infected) and in a flock the disease spreads very fast. | A bacterial infection is usually confined to one part of the body. Bacterial infections usually spread slow through a flock |
| Examples of viral infections:<br><br>Avian Influenza, New Castle Disease, Fowl pox, Gumboro | Examples of bacterial infections:<br><br>Salmonella, Fowl Cholera, E. Coli, Mycoplasma, Infectious Coryza |

**Treatment of viral infections**

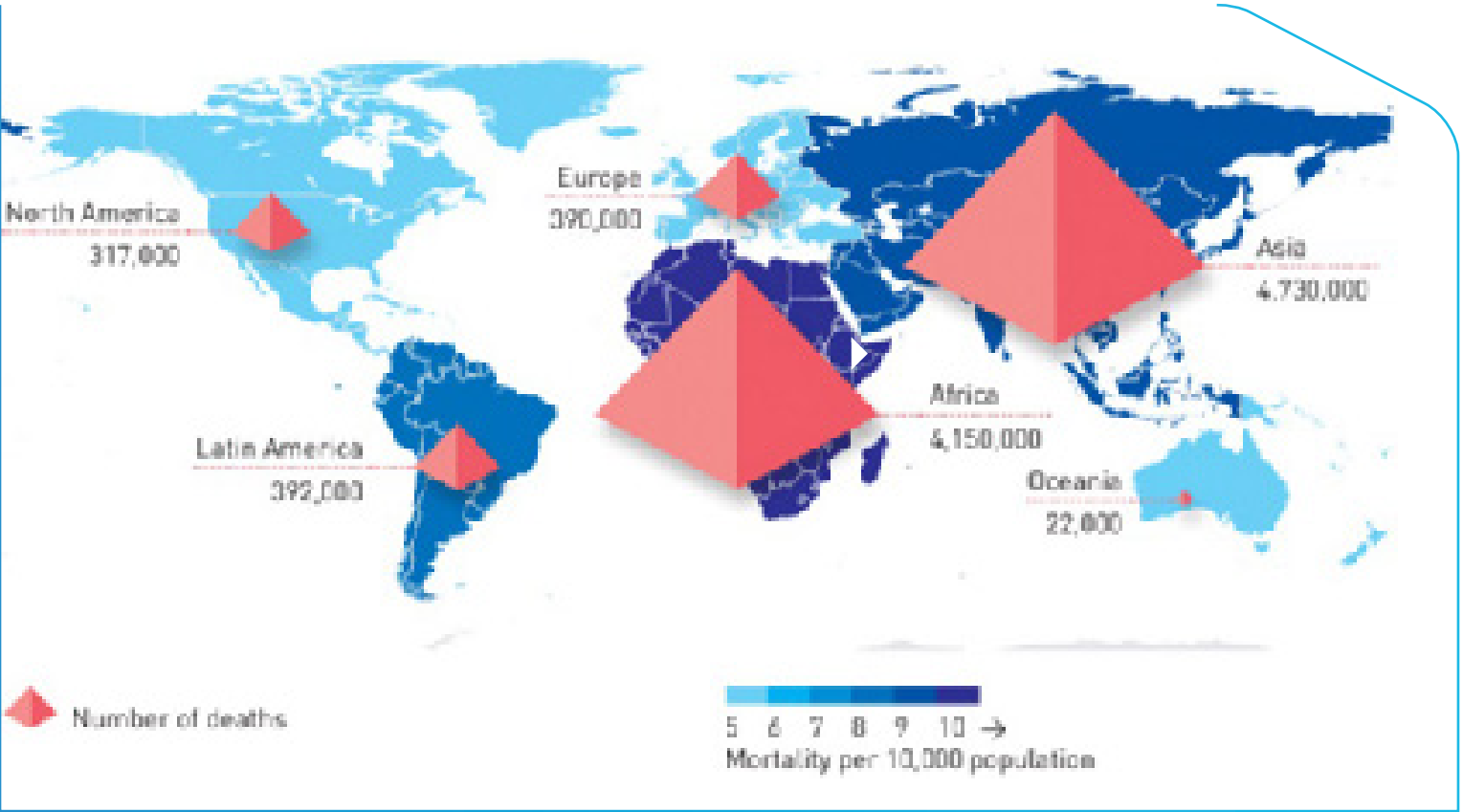
Viruses are not sensitive to antibiotics, so it is not necessary to apply antibiotics during a viral infection. During a viral infection, it is important to give good care to the sick flock, by providing easily digestible feed, clean drinking water and if necessary a well heated environment to support. Also providing extra electrolytes in drinking water during diseases with diarrhoea, can help to relieve symptoms.

**Treatment of bacterial infections.**

Bacterial infections spread not as fast as viral infections, but they can be difficult to eradicate from a farm. Bacteria are susceptible to antibiotics, so it is possible to treat the animals using a suitable antibiotic treatment. To know which antibiotic is most suitable, it is necessary to know which disease you need to treat. Making the right diagnosis is very important, as is to test for the sensitivity of the bacteria for the antibiotics. We now know, that antimicrobial resistance is a huge problem in fighting diseases.

### 7.1 (Ab)use of Antibiotics

Antimicrobial resistance, cause of deaths, 2050



**Causes of antimicrobial resistance:**

- Frequency of antibiotic use: do not use antibiotics too frequently or as a prevention
- Underdosing
    - Weight animal, water consumption
- Use of antibiotic mixtures
- Duration: therapy length and respect the prescribed withdrawal period (explain withdrawal period: the minimum period of time from administering the last dose of medication and the production of milk, meat and/or eggs)
- Diagnosis
- Usage of resistant drugs
- Storage of medicines: in a safe place, out of reach of children


The animal on the left weighs a lot less than the animal on the right, and needs a different dosage of antibiotics!

# 8 Health indicators

It is very important to be able to see in a flock which chickens are healthy and which chickens have a disease. For that purpose, you can look at health indicators. Health indicators are important because:

- They are an early indicator of disease
- Good health = good production results
- They can tell something about animal welfare
- Efficient use of feed (sustainability)
- Reduction antibiotics

## 8.1 What to look for:

**Alertness:**

Are the chickens active and respond to you, or are they dull and do not respond?

Good sign

Bad sign

**Uniformity:**

Chickens of the same age and breed, should all be the same size. If they are not similar, this is a sign that the feed intake or digestion is compromised.

Nice, uniform flock

Different sizes and showing problems

**Eyes**

Eyes should be clean, bright and without discharge. Dirty eyes usually indicate a respiratory disease

Clean, healthy eyes

Discharge from eyes and beak

Watery, infected eyes

**Spread over the barn:**

The chickens should be evenly spread over the barn. If there are empty spaces, this can indicate a draft or temperature changes , which can cause stress or disease. If the chickens are huddled together, this can indicate cold, or even disease.

Good, even spread over the barn

Empty spots, indicating un-even ventilation

**Crop filling:**

Crop filling can be used to test whether chicks are eating or not and is an important method to detect for disease in individual birds.

Full crop on the left picture

Empty crop on the right picturepicture

**Litter quality:**

Litter quality says something about the ventilation, but also about the digestive system. If there is a problem with diarrhoea, litter will be wet and birds will get food pad lesions.

Dry litter, birds are healthy

Wet litter, reason for concern

**Faeces:**

The faeces can give a lot of information about the health of the bird and about the quality of the feed. Please be aware that there are 2 different kinds of faeces in birds: normal faeces, which comes from the large intestines, and caecal faeces, which comes from the cecum, a part of the gut where bacterial digestion takes place.

Normal cecal faeces

Diarrhea, cecal faeces is very foamy and light

## 8.2 Differential diagnosis

If you look at disease symptoms, you could make a list of every possible disease occurring at those symptoms. This is called a differential diagnosis. This means that if you see a symptom like coughing, there are many diseases which can cause this symptom. It is usually necessary to do laboratory tests to really diagnose a certain disease.

**Respiratory diseases:**

| | |
|---|---|
| • Avian Influenza | virus |
| • New Castle Disease | virus |
| • Infectious Bronchitis | virus |
| • Mycoplasma | bacteria |
| • Infectious Coryza | bacteria |
| • Fowl Cholera (Pasteurellosis) | bacteria |
| • Aspergillosis | fungus |
| • E. Coli (secondary infection) | bacteria |

**Diseases of the digestion system:**

| | |
|---|---|
| • Salmonella | bacteria |
| • Coccidiosis | parasite |
| • Necrotic Enteritis (Clostridium perfringens) | bacteria |
| • E. Coli (secondary) | bacteria |
| • Intestinal parasites (worms) | parasite |
| • (Infectious Bronchitis) | virus |
| • Reovirus | virus |
| • Adenovirus | virus |

**Neurological diseases:**

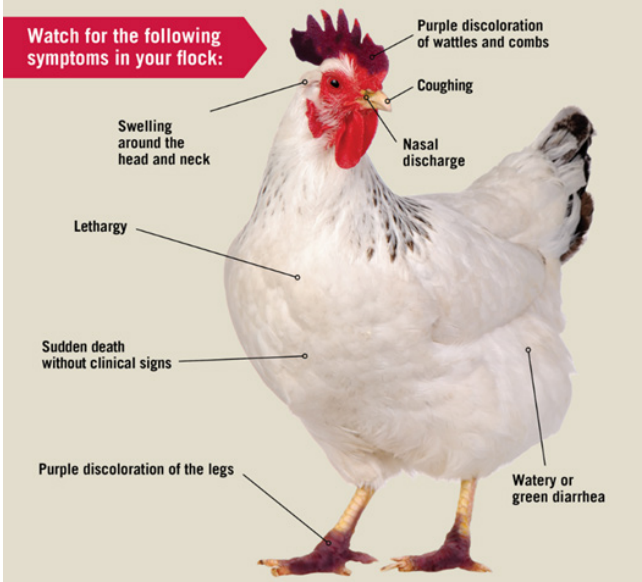
| | |
|---|---|
| • New Castle Disease | virus |
| • Marek's disease | virus |
| • Avian Leucosis | virus |
| • Clostridium (Botulism) | bacteria |
| • Vitamin deficiency (vit B, E) | deficiency |
| • Avian Encephalomyelitis | virus |

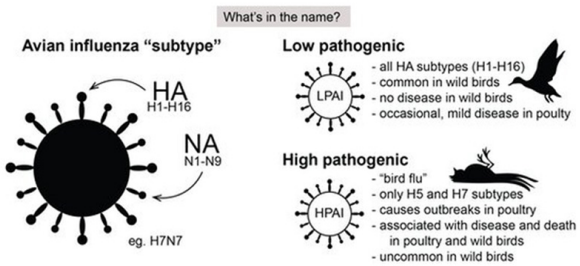
Making a good diagnosis is very important, because only than you know what causes the disease, how (and if) it can be treated and what you can do to prevent this disease in the future by implementing management measures.

# 9 Poultry diseases

## 9.1 Viral diseases

### 9.1.1 Avian Influenza



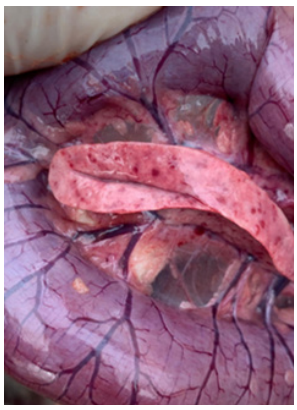

Highly Pathogenic AI spreads rapidly causing serious disease with high mortality (up to 100% within 48 hours) in most poultry species (except domestic waterfowl). Low Pathogenic AI causing generally a mild disease, may easily go undetected.

Respiratory signs with on the background dead chickens

Cyanosis on legs, ...

... combs and wattles

Petechiae (point bleedings) in gizzard ...



... and on the pancreas

Point bleedings on the peritoneum

White spots on the spleen

Although the above pictures give a clear view of possible symptoms, every strain of the virus can look differently and give different symptoms also depending on infected bird species, age, immune status and environmental factors. So if you experience high mortality, it is important to test the animals for AI as quickly as possible. AI spreads very fast, and because the mortality is very high, it is important to act fast to stop the disease from spreading.

**Symptoms**

Low pathogenic AI:

- Listlessness
- Ruffled feathers
- Huddling
- Reduced feed and water intake
- Sometimes diarrhoea
- Mild to severe respiratory signs
    - o Coughing
    - o Sneezing
    - o Rales
    - o Nasal discharge
    - o Oedema of the head

High pathogenic AI:

- General signs
    - o Listlessness
    - o Reduced feed and water consumption
- Respiratory signs
    - o Sneezing
    - o Coughing
    - o Rales

- Neurological signs
    - o Tremors of head and neck
    - o Torticollis
    - o Inability to stand
- Severe bleedings
- Sudden death

**Transmission**

Transmission occurs via faeces, water, in the air, via people, infected material and from bird to bird.

**Treatment**

No treatment is possible, this disease is compulsory to report to the government in some countries.

**Prevention**

Management:

- High level of biosecurity
    - o Preventing direct contact with wild birds or droppings of wild birds
    - o Reduction of visitors, other poultry and materials on farm which have been in contact with possible sources of infection.
    - o Intensive pest control
- If an infection occurs: immediate culling and strict cleaning and disinfection

**Vaccination:**

Many countries forbid to vaccinate against AI, see for rules and regulations a veterinary surgeon in your country.

### 9.1.2 Newcastle disease

Caused by Avian paramyxovirus serotype 1

All domestic and wild avian species of all ages can be infected, present all over the world, in many countries it is endemic (present all year round).

Mortality can be as high as 90-100%, it spreads very fast. It can spread through the air, by faeces, materials, insects and rodents, people and from (wild) bird to bird.

**Clinical signs:**

- Respiratory distress:
    - o Gasping
    - o Coughing
    - o Sneezing
    - o Rales
    - o Nasal discharge
- Greenish and watery diarrhoea
- Depression
- Neurological signs:
    - o Muscular tremors
    - o Paralyzed legs and dropping wings
    - o Twisted neck (torticollis)
    - o Spasmes
    - o Ataxia
    - o Walking in circles
- Sudden death
- Variability in signs
- In laying hens:
    - o partial to complete loss in egg production
    - o poor eggshell quality

Torticollis (twisted neck)

Cyanosis on comb

Greenish, watery diarrhoea

Cyanosis on the comb and depression

Bleedings on the mucosa of the gizzard

Cyanosis on the legs

**Treatment**

No treatment possible, report to the authorities is compulsory in a number of countries.

Prevention

- Control of insects and rodents
- Control of water and feed quality
- Use of good litter quality
- Use of adequate biosecurity measures
- Vaccination

### 9.1.3 Infectious Bronchitis

Acute and highly contagious viral disease of the upper respiratory tract in poultry. It is caused by the Infectious Bronchitus Virus (Coronavirus).

There are many different strains of the virus, resulting in different disease patterns and symptoms. All chickens can be infected, and usually it spreads quickly within the whole flock. The mortality % depends on the strain. There are also some strains of the IB virus which cause kidney failure. If that is the case, mortality usually is high.

The virus spreads from **bird to bird** (oral route), **through the air**, and v**ia materials and persons.**

**Symptoms:**

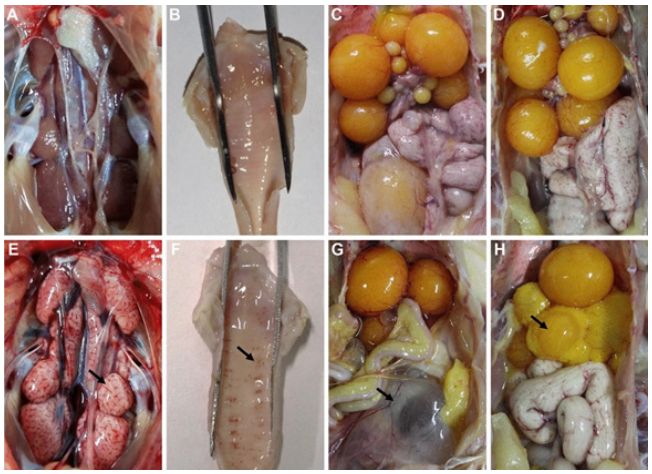
- Respiratory form:
    - o Coughing
    - o Gasping
    - o Sneezing
    - o Rales
    - o Nasal discharge
    - o Ocular discharge
    - o Anorexia
    - o Reduced weight gain
- Nephrogenic (kidney) form:
    - o Depression
    - o Wet droppings
    - o Increased water intake
- Low egg production (up to 70% drop in egg production). This can recover within 6-8 weeks
- When young hens are infected, the oviduct can be permanently damaged, leading to hens with a reduced or no egg production at all.
- Misshapen eggs (usually wrinkled eggs
- Unpigmented egg shells
- When opening the egg: watery egg white

Depression

Gasping for air

Nasal discharge

Left a normal egg, right a misshapen egg (IB




Source: Pathogenic characteristics of a QX-like infectious bronchitis virus strain SD in chickens exposed at different ages and protective efficacy of combining live homologous and heterologous vaccination Lei Shao, Jing Zhao, Lihua Li, Xiuying Huang, Huiming Yang, Jinlong Cheng, Changqing Liu & Guozhong Zhang, Veterinary Research volume 51, Article number: 86 (2020)

**Treatment**

No treatment is possible. Mortality can be reduced by supportive treatment (providing extra heat, good air quality and no overcrowding). In case of the nephrogenic strain, it can help to reduce the protein concentration in the feed and to provide electrolytes in the drinking water.

**Prevention**

- Strict biosecurity
- Prevention of stress
- Vaccination

### 9.1.4 Marek's disease

Marek's disease is a very infectious disease, caused by a herpesvirus. This herpesvirus has different strains: mild, virulent, very virulent and very virulent plus.
The virus produces tumours, most of the time in the nerves of the chickens which are affected. Because the nerves changes when they are affected, chickens become paralyzed or show other neurological symptoms..
Young birds are very sensitive to an infection with the virus, most infections occur during the first days of life. After 16 weeks, the birds are more resistant against the virus.

**Transmission**

MDV is shed in large quantities from the feather follicles and spreads rapidly from bird to bird or by indirect contact, through dust and dander. The dust and dander are inhaled by the chicken. No vertical transmission, but infected chickens become carriers and shed the virus via feather follicles lifelong. The virus is extremely stable and can survive for months in litter or dust.

**Symptoms:**

Symptoms usually occur from the age of 2-5 months onwards, but can also been seen at 3-4 weeks of age. Peak mortality usually occurs around 10-13 weeks of age.

- Neurological form:
    - o Depression
    - o (asymmetric) progressive paresis
    - o Paralysis of one or both wings
    - o Death
    - o Increased condemnations
- Visceral form
    - o Emaciation
    - o Listlessness

Lameless

Enlarged feather follicles

Paralysis

Enlarged nerve of the leg

**Treatment**
No treatment is available. Severely affected flocks should be culled.

**Prevention**
- Strict biosecurity measures, especially with regards to dust and dander
- Avoiding of immunosuppression (heat stress, mycotoxins, bad feed quality)
- Vaccination

### 9.1.5 Fowl pox

Fowl pox is a slow spreading viral disease, caused by the Avipoxvirus. It is transmitted by **direct contact**, when the virus is introduced via injured skin. It is also transferred via indirect contact by a **contaminated environment, insects (mosquitos) or via the air**.
There are two forms of Fowl pox: the dry pox (cutaneous/skin form) and wet pox (diphteric form), where you can find lesions on mucous membranes in the mouth and upper respiratory tract.

**Symptoms:**
Cutaneous form:
- Wart like lesions on non-feathered skin area's such as comb, wattles, eyelids, legs and feet
- Reduced feed and water consumption
- Reduced growth rate

Diptheric form:
- Yellowish lesions in the mouth, oesophagus and/or trachea
- Reduced feed and water consumption
- Mild or severe respiratory signs
- Reduced growth rate
- Drop in egg production
- Mortality

Cutaneous (dry) form of Fowl Pox

Diphteric (wet) form of Fowl Pox

**Treatment:**
An effective treatment for Fowl Pox doesn't exist. If the disease is first detected, vaccination can be initiated and this will not only stop the disease from spreading, but also helps the birds recover quicker.
Prevention:
- Good biosecurity measures
- Regular cleaning and disinfection
- Avoiding multiple ages on a farm
- Control of cannibalism to limit skin lesions
- Control of dust
- Control of mosquitos and other insects
- Vaccination (wing-web method)

### 9.1.6 Infectious Bursal disease (Gumboro disease)

Gumboro disease is caused by the infectious bursal disease virus (Avibirnavirus), and 2 strains of the virus are known: serotype 1 and serotype 2, whereby serotype 1 is very virolent, and serotype 2 is an low virulent strain.

Gumboro disease affects the immune system, and if birds between the age of 1 and 3 weeks are affected, this will cause a severe, long-lasting immunosuppression. These birds will not respond to vaccinations and will be very vulnerable for any disease. If chickens in the age of 3-6 weeks are infected, they will also suffer from clinical disease signs, but the effect on the immune system will be only temporary.

IBD is shed into the faeces, and transmission occurs from bird to bird, or through indirect contact by feed, water, litter, materials, insects and other animals like rodents. The virus is very stable and is extremely resistant against most disinfectants and can survive in the environment and cause new disease cases for several months.

**Symptoms:**
- Whitish or watery diarrhoea
- Soiled vent feathers
- Anorexia
- Depression
- Ruffled feathers
- Trembling
- Dehydration
- Mortality

Sick flock, not alert

Individual bird, depressed

Conjunctivitis

Bleedings in thigh muscle

Enlarged, edematous Bursa of Fabricius

Bleeding and inflammation inside Bursa

**Treatment:**
No treatment is available for Gumboro disease. Only good quality feed, supportive treatment like electrolytes and acids in the drinking water will help to support the animals and can prevent high mortality, which also depends on the virulence of the strain.

**Prevention:**
• Good biosecurity, including control of personal and material movements
• Good application of cleaning (with a detergent) and disinfection after a virus outbreak is necessary to prevent new infections. Disinfectants which could be effective are formalin, iodine complexes and quaternary ammonium compounds
• Application of All-in-all-out
• Vaccination: timing of vaccination is very important. If you are too early, maternal antibodies will neutralize the vaccine. If you are too late, the birds have already been at risk. If there is a vector vaccine or in-ovo vaccination available, this will protect the birds the best.

## 9.2 Bacterial diseases

### 9.2.1 Chronic Respiratory Disease (Mycoplasma Gallisepticum)

Chronic respiratory disease is caused by Mycoplasma Gallisepticum and occurs worldwide. CRD belongs to one of the bacterial diseases which is causing many clinical and economic problems in the poultry industry.

Mycoplasma is transmitted by direct contact, through the air and via vertical transmission through the egg to the newly hatched chick. Chicks which are infected, can stay a carrier of Mycoplasma for their entire life span.

Symptoms:
• Sneezing
• Tracheal rales
• Nasal and ocular discharge
• Conjunctivitis
• Reduced feed consumption
• Weight loss
• Reduced egg production

Ocular discharge

Conjunctivitis

**Treatment:**
Mycoplasma is a bacterial disease, so when an infection occurs, it is possible to treat this with antibiotics. It is however not possible to remove the disease entirely from the farm, because carriers remain, also after antibiotic treatment. As soon there is stress on the farm, the carriers will start spreading the disease again, and a new outbreak can occur.

Antibiotics which can be used during an outbreak of Mycoplasma are:

Oxytetracycline, chlortetracycline, doxycycline, spiramycin, Tylosin and enrofloxacin (this one only as last resort, because it causes cross resistance).

**Prevention:**
• Only buy chicks from a Mycoplasma free parent stock
• Only one age should be on the farm, so that transmission in between flocks is not possible
• Good cleaning and disinfection
• Good water quality
• Restriction of contact between chickens and wild birds
• Control of rodents
• Changing of clothing and footwear after visiting other birds or flocks
• Vaccination

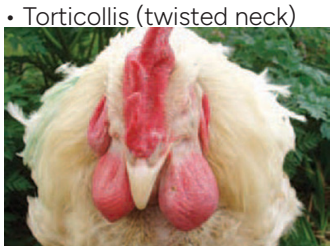
### 9.2.2 Fowl Cholera

Fowl cholera is caused by the bacterium Pasteurella Multocida.There are two forms of the disease known: an acute systemic disease where many birds in the flock fall ill and die (suddenly, sometimes this is the first sign of disease), and a chronic form, which causes swollen heads, swollen wattles and respiratory signs.

Fowl cholera is transmitted by wild birds, dogs, cats and pigs and by chronically infected birds (carriers). Within the flock, the disease is spread by bird-to-bird contact, by infected materials contact with secretions, faeces and by ingestion of infected feed or water.

**Symptoms:**
Acute form:
- Fever
- Anorexia
- Ruffled feathers
- Oral and nasal discharge
- Diarrheal
- Laboured breathing
- Cyanosis (blue comb or legs)
- Sudden death

Chronic form:
- Swollen wattles, sinuses, joints, foot pads
- Conjunctivitis
- Rales
- Torticollis (twisted neck)



Swollen wattles and depression

Torticollis (twisted neck)

Swollen sinusses

**Treatment:**
Because Fowl cholera is caused by a bacteria, it can be treated with antibiotics in the drinking water. Suitable antibiotics are (depending on the susceptibility of the strain) oxytetracycline, doxycycline, TMPS, amoxycillin, flumequine, spiramycin and enrofloxacin (as last resort, causing cross resistance).

**Prevention:**
- Strict sanitation in poultry houses
- Control of rodents
- No access of dogs, cats or pigs to the poultry area
- All-in-all-out management
- Disinfection of materials and limited access of persons
- Vaccination

### 9.2.3 Salmonella

In poultry, there are different strains of salmonella prevalent. The most important ones are Pullorum disease (caused by Salmonella Pullorum), Fowl typhoid (caused by Salmonella Gallinarum) and Paratyphoid infection (caused by other types of Salmonella, like S. Enteritidis, S. Typhimutium etc.).

Salmonella is an important disease in poultry, because it can also infect people (zoonosis: a disease in animals which can be transferred to people and causes disease in people).

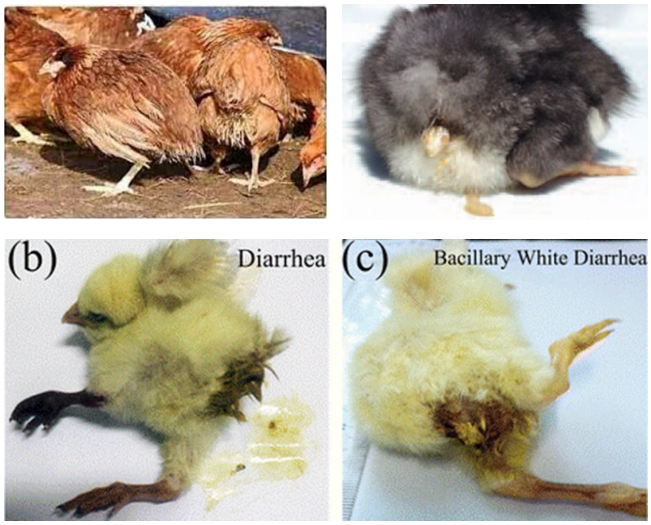
Salmonella is a difficult disease to eradicate, because it is (just like Mycoplasma) vertically transmitted. Infected birds remain carriers for the rest of their life. This means that in times of stress, they will start shedding the bacteria again, causing another outbreak of salmonella. Salmonella can be transmitted from parent to offspring (vertical transmission), from bird-to-bird, by infected materials, eggs, manure, wild birds, rodents, feed and drinking water.

**Symptoms:**
Because there are different strains of Salmonella in poultry, the symptoms are very divers.

Pullorum disease:
Onset of the disease depends on the moment of infection. If the disease is vertically transmitted, the first signs can already be seen in the hatchery.
- Decreased hatchability
- Weak, pumping respiration
- Decreased appetite
- Slime in faeces
- White, chalky urates on the cloaca
- Arthritis
- Blindness

Fowl typhoid:
Same symptoms as above, but also a high mortality rate, up to 90 %. In adult chickens:
- Lower feed intake
- Lower egg production
- Lower hatchability
- Inactivity
- Mortality

Parathypoid infections:
- Watery diarrhea
- Ruffled feathers
- Drooping wings
- Closed eyes
- Loss of appetite
- Dehydration
- Depression
- Poor growth




**Treatment:**
Because birds remain carrier, also after treatment, it is not advisable to treat or quarantine birds. As soon as they are recovered and experience stress, they will start shedding the bacteria again. Because parent stock can transfer the disease to the offspring, it is advisable to cull the infected parent stock to prevent spread of the disease.
If necessary, birds can be treated with TMPS, Oxytetracycline, doxycycline, florfenicol, flumequine or colistin.

**Prevention:**
- Obtaining chicks from Salmonella free parent stock
- Culling of infected (breeder) flocks
- Use of pelletized feed to reduce introduction of salmonella
- Use of acids in the drinking water or feed
- Control of rodents, insects (red mite in particular) and wild birds
- Appropriate disposal of dead birds
- No quarantine of sick birds
- All-in-all-out
- Biosecurity and cleaning and disinfection.

## 9.3 Parasites

In poultry, there are different parasites known. We can divide them in different groups:

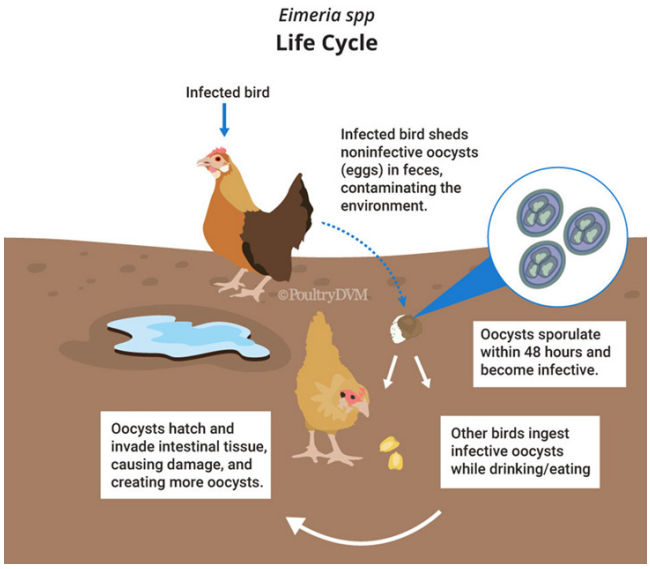
**External parasites:**
- Lice
- Mite

**Internal parasites:**
- Worms
- Coccidiosis

Parasites can cause stress, can carry other diseases with them and can also cause anaemia (blood loss), nutrient deficiency. They can also damage intestinal cells in case of cocciciosis or worms and subsequently cause diarrhoea.

### 9.3.1 Coccidiosis

Coccidiosis is an infection which has a huge impact on the poultry industry. It is caused by protozoa (one celled parasites) which need gut cells to multiply. When a chicken gets infected, the protozoa finds gut cells in the preferred part of the gut, and enters this cell to produce eggs. When the eggs are ready to hatch, the gut cell gets completely destroyed. When many gut cells are infected, massive parts of the gut are damaged, which results in (bloody) diarrhoea.




There are several species of coccidiosis, all belonging to the Eimeria family. Each of these species have a special location as their favorite, and cause therefore different symptoms.

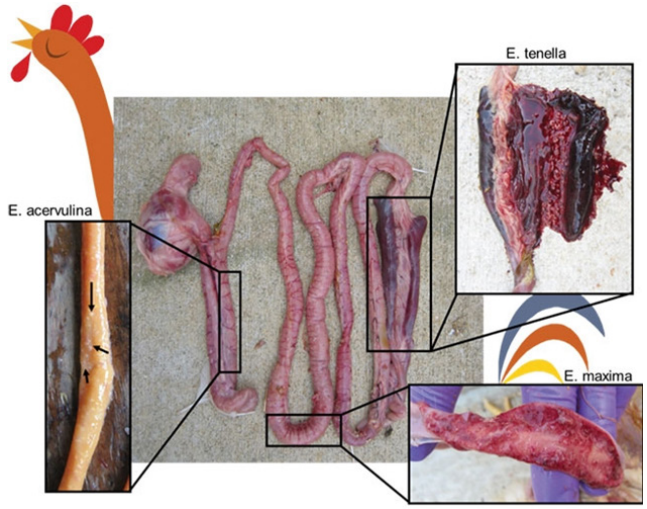
| Species | *E. Acervulina* | *E. maxima* | *E. Brunetti* | *E. necatrix* | *E. tenella* |
|---|---|---|---|---|---|
| Portion of the intestine where lesions are mostly seen |  |  |  |  |  |
| Symptoms | Anemia, light enteritis, loss of appetite | Diarrhoea, droppings may be flacked with blood | Enteritis, occasionally bloody | Bloody enteritis, drops in feed intake | Bloody droppings, reduce in feed intake |
| Pathogenicity | High morbidity, low mortality | | Dysentery, high morbidity, high mortality | | |

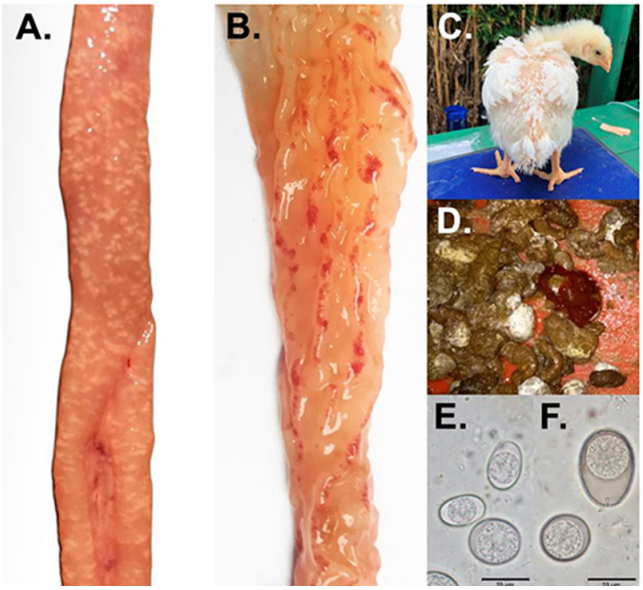
When chickens become infected, they start shedding oocytes (infected eggs) during several weeks in the faeces. These oocytes need time, warmth and humidity to become infectious. They can be spread from **bird-to-bird, wild birds, rodents, insects, dust, contaminated equipment, water and feed and people (boots).**

Oocysts are extremely resistant and are not harmed by most disinfectants, therefore **contamination** of the poultry house is the most important way of transmission.

**Symptoms:**

- Reduced growth rate
- Reduced feed consumption
- Increased water consumption followed by reduced water consumption
- (Bloody) diarrhoea
- Ruffled feathers
- Depression




A. E. Maxima lesions in duodenum B. Bleeding and infected parts in the mucosa of the gut. C. Depressed bird D. Blood and fibrin in faeces. E. Oocysts under the microscope

**Treatment**

To prevent coccidiosis, it is important to let the birds build up immunity. This means, if you treat to fast at the point of an outbreak, there will be no build up of immunity and this can cause reoccurrence of the disease. Coccidiosis infection can be treated with anticoccidial drugs in the drinking water:

Amprolium, diclazuril, toltrazuril and sulphonamides. Don't always use the same treatment, because just as with bacteria, resistance can occur.

**Prevention:**

- Prophylactic use of an anticoccidial drug in the feed, like monensin or other drugs
- Prevent wet litter, because this increases the risk of an outbreak
- Hygiene and biosecurity
- Vaccination

### 9.3.2 Worms

There are a few different kinds of worm species:
Round worms:

- Ascaridia
- Cappilaria
- Caecal worms (Heterakis)
- Gapeworm (Syngamus)

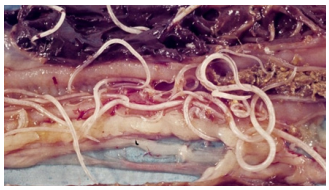
**Tapeworms**

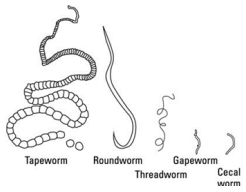
Each worm species have their own lifecycle, route of transmission and spot in the birds which they prefer. Also severity of disease is depending on infection pressure (number of worms) and species.

**Symptoms:**

| Specie | Signs | Transfer | Treatment | Severity |
|---|---|---|---|---|
| Ascarida | diarrhoea, reduced growth, drop in egg production | Bird-to-bird<br>Grasshoppers, earth worms | Ivermectin, fenbendazole, piperazine | severe |
| Heterakis | Almost non | Litter, soil, earthworms, houseflies, contaminated feed or water | Fenbendazole | Mild, but carrier of Histomoniasis |
| Capillaria | Swelling of crop and oesophagus, | Contaminated feed or water, earthworms | Ivermectin, Fenbendazole | severe |

| Specie | Signs | Transfer | Treatment | Severity |
|---|---|---|---|---|
| | difficulty to swallow, enteritis, diarrhoea, Lower egg production | | | |
| Gapeworm | Coughing, anaemia, Lower egg production | Contaminated feed or water, earthworms, snails, insects | Ivermectin, Fenbendazole | mild |
| Tapeworm | Reduced growth, weakness, lower egg production, deficiencies | Earthworms, snails, slugs, insects and contaminated feed and water | Fenbendazole | |






**Prevention:**

• Strict sanitation of feeders, drinkers and bedding
• Control of secondary hosts, such as beetles, roaches, grasshoppers and earthworms
• Use of a deworming program (in layers every six weeks or after positive faeces samples)
• No multi age keeping on farms

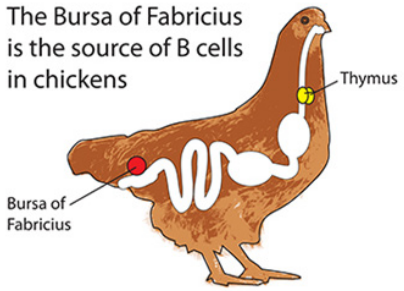
## 10 Chicken immune system

A chicken can defend itself in 3 ways:

• By using barriers to prevent pathogens from entering the body. These barriers are:
  - o Skin and hairs (also hairs on the inside of the trachea)
  - o Mucus (nasal mucus, tears in the eyes) and good bacteria in the gut which form a protective layer to prevent pathogenic bacteria to attach and enter to the gut cells.
  - o Acid (stomach acid, urine in the bladder)

• Direct response: the immune system has soldiers which attack every strange object which enters the body. This reaction is very fast, and causes an infection which you can see as redness, swelling, puss and sometimes a fever. These soldiers can transfer information to the other part of the immune system, to recognize and prevent an attack next time. This happens by the adaptive immune system.

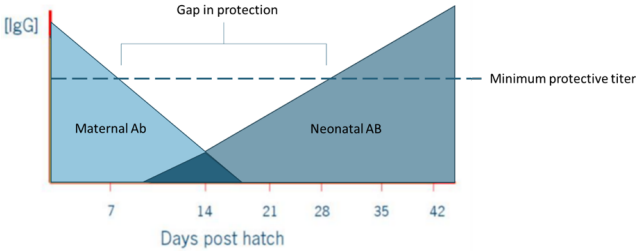
• Adaptive immune system: this system is responsible for remembering the cause of an attack and is able to prevent it from happening next time. To be able to do so, it needs trained soldiers (B cells). These B cells are trained in birds in the Bursa of Fabricius. The B cells produce antibodies to fight the infection.




When a young chick is hatched, it receives antibodies from the mother (maternal antibodies) to be able to protect itself. The problem in young chicks is, that besides the antibodies from the mother, they have no protection:

• There is not enough acid produced in the stomach to prevent bacteria from entering the intestines
• There are not yet good bacteria to form a preventative layer in the intestines, so it is easy for pathogenic bacteria to attach and enter gut cells and causing an infection
• The immune system is not trained yet, and the "soldiers" are still weak.

That is why, young chicks should be protected very well against diseases.




If the B cells are not trained or are destroyed, the birds have no means to fight disease and become immunosuppressed.

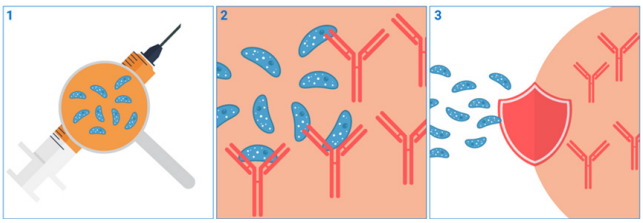
Diseases which can cause immunosuppression are:

• IBDV (Infectious Bursal Disease Virus, Gumboro)
• Marek's disease
• Chicken infectious anemia virus
• Mycotoxins
• Stress
• Deficiencies

To make sure the birds have a strong immune system and are able to fight infections, it is important to prevent the causes above. This is done by providing a good quality feed, which contains enough vitamins and minerals, and is absent of mycotoxins. When it is not known whether a feed contains mycotoxins, it is possible to add a mycotoxin binder to the feed.

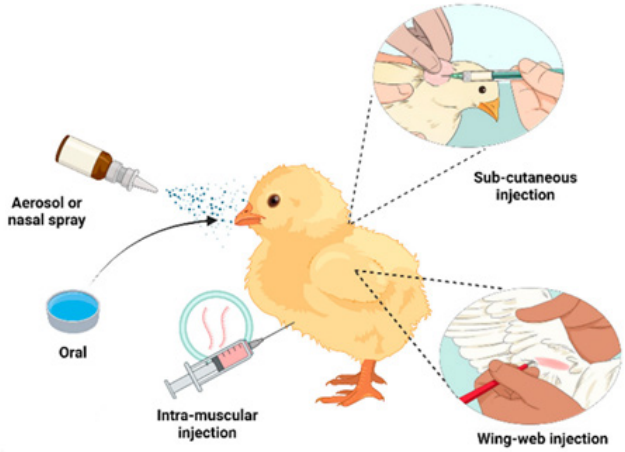
To prevent problems caused by Gumboro and Marek's disease, it is necessary to vaccinate the birds against these diseases.

When you provide vaccination, you activate the adaptive immune system of the bird and provide memory about this particular disease and the birds immune system will be able to prevent and fight this disease in the future.




What types of poultry vaccines are there available on the market?

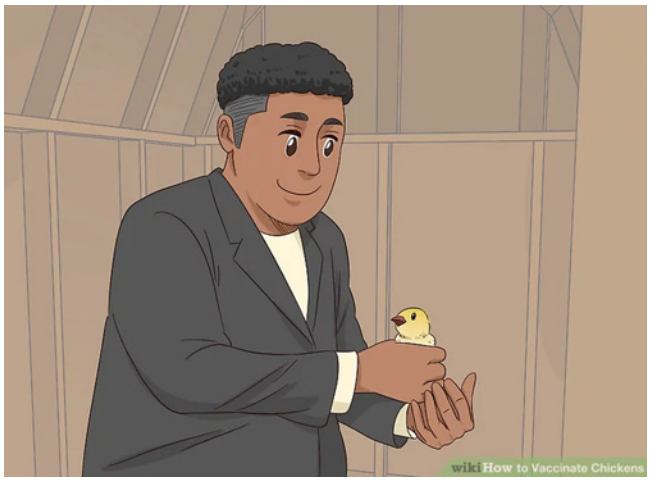
- Spray
    - o Big drop size (upper airways)
    - o Small drop size (lower airways)
- Eye drop
- Drinking water
- Injection
- Subcutaneous (under the skin)
- Intramuscular (in the muscle)
- In Ovo (in the egg in the hatchery)



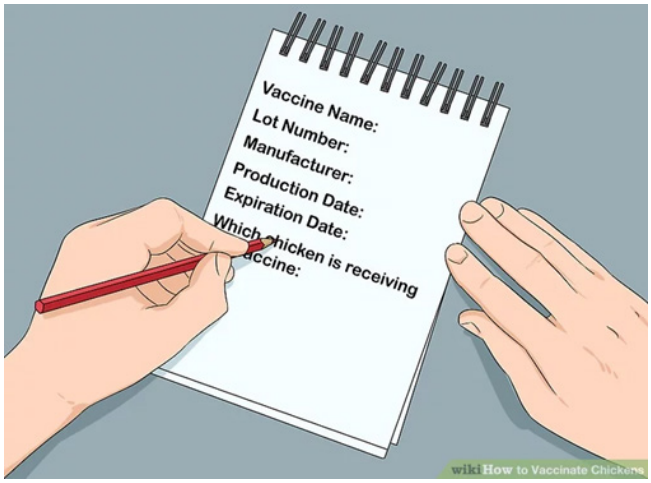

The other difference is between live (attenuated, this means that the pathogen is used as a whole, but that it is no longer able to cause clinical disease) and dead vaccines. The advantage of a live vaccine, is that it is still able to spread within a flock, so not all the birds need to be vaccinated. The immune system will have a strong response to this vaccination, also at the point of entry (where the pathogen usually enters the body, like in the upper respiratory tract).

When using a dead vaccine, this needs to be injected, doesn't spread to other chickens, so all chickens need to be vaccinated, and only provides antibodies, so no protection at the point of entry.`

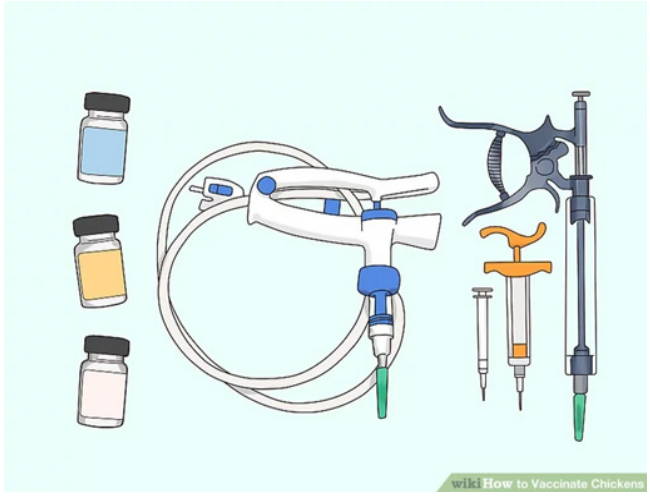
## 11 Vaccination procedure



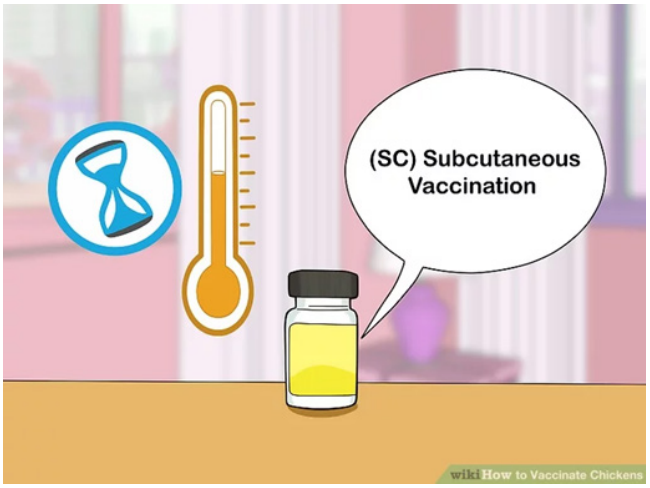

Make sure that the chickens are healthy, never vaccinate sick chickens. Exception: Fowl pox




Always write down the date of vaccination, vaccine name, batch number, expiry date and which chickens you are vaccinating.




Prepare everything well in advance and make sure you have all the ingredients and materials you need to perform the vaccination.

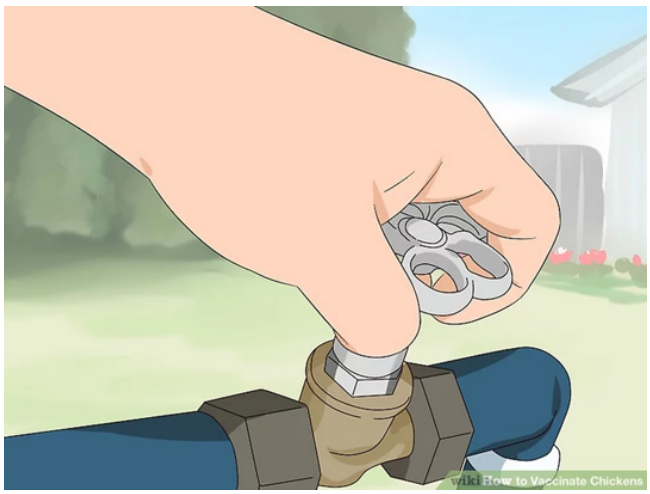



Keep the vaccine at the right temperature, also during transport, storage and preparation. Make sure the vaccine is not past the expiry date and use the mixed vaccine within an hour. After one hour, the action of the vaccine will be reduced and your chickens won't be fully protected.


If you want to do a vaccination in the drinking water, calculate how much water the chickens can drink in one hour. Use the following rule of thumb: per day of age, they should receive 1 L per 1000 chickens up to a total of 40 litres. So if you have 1000 chicks and they are 16 days of age, you should prepare 16 L of drinking water, mixed with 1000 dosages of the vaccine.

If you have 500 chicks, of 16 days, they should receive 8L drinking water, mixed with 500 dosages of the vaccine.

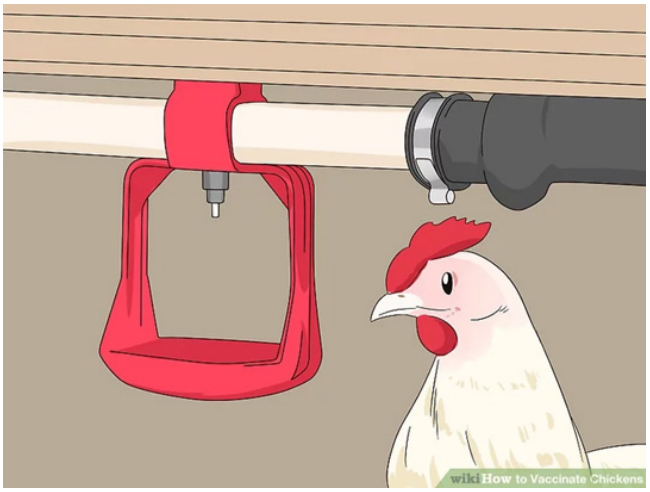

Clean your watering system, but don't use any detergents or disinfectant, because this can kill the vaccine. Also make sure the drinking water doesn't contain any chlorine. If necessary, use bottled water.



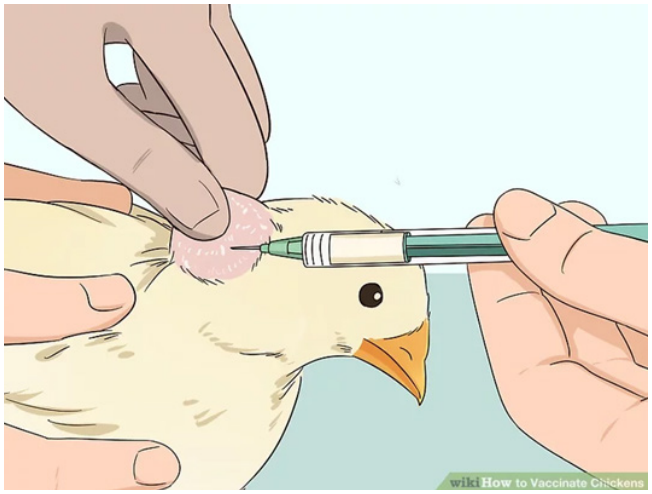

Make sure to remove all drinking water sources 1 hour prior to the vaccination. You want the birds to be thirsty, so that they all receive enough of the vaccine.


Stabilize the water 30 minutes before adding the vaccine using 2 g skimmed milk powder per liter of drinking water or a commercial stabilizer to neutralize any remaining chloride and to make the solution more stable to support the vaccine.

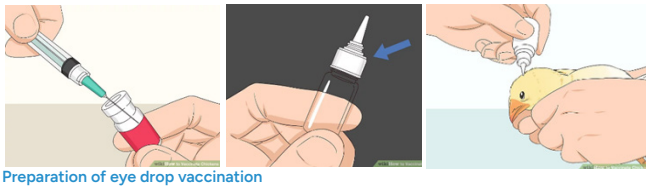

Use a clean bucket and add the stabilized water into the bucket. Put on gloves, remove the vaccine bottle from the ice or fridge and put the bottle under the water. Only when the bottle is under the water, remove the lid and stir the solution. Then put this solution in the calculated amount of drinking water and stir well.




Start providing this water to the chickens as only source of drinking water. Make sure you have enough drinkers to provide the solution to all the birds at the same time. If you have used a commercial stabilizer, this also contains a colour, so you can check in the mouth whether all chickens received the vaccine.

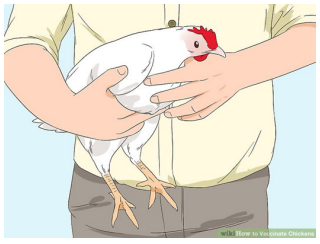



Injection under the skin



Preparation of eye drop vaccination


Preparation of wing web vaccination

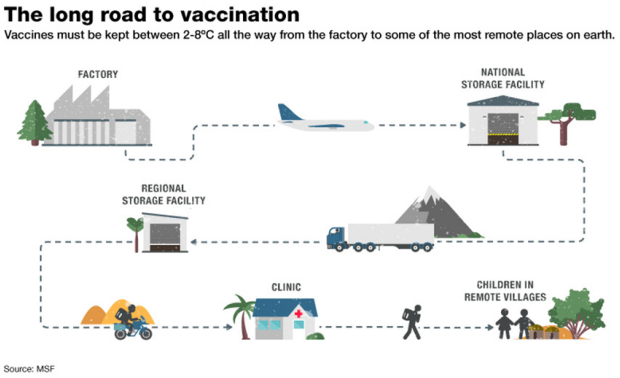


Always check your chickens well after vaccination and provide extra vitamins to support the immune system.

**Vaccinated birds got sick after vaccination, how is this possible?**

1. Production error pharmaceutical company (wrong antigens, insufficient antigens, contamination, wrong strains, ..)
2. Transport (too warm, refrozen)
3. Storage (Pharma, wholesale, vet, farm)
4. Preparation
5. Application (device + method + timing!)
6. Water quality (contamination with disinfectants, too warm)
7. Dose (1/bird)
8. Type of vaccine (turkey strains -> broiler birds; too mild, too hot)
9. Interference with maternal immunity (IBD!!)
10. Immunosuppressive underlying disease (Marek, Chicken Anaemia Virus (CAV), mycotoxins, Avian Adeno-Associated Virus (AAAV), IBDV)
11. Infection already present at farm before protection from vaccine

There are many things which could go wrong before, during and after vaccination, so make sure that the vaccine is kept cool during all steps, and you stick to the prescribed method of vaccination.




If it is not possible to keep the cold chain, then try to use vaccines which can be stored at higher temperatures.

**Example vaccination schedule backyard chickens**

| When | Types of Vaccines | Method |
|---|---|---|
| Day1 | Marek's | Inject hatchery |
| Day6 | Newcastle (NCD), Infectious Bronchitis (IB) | Eye drop |
| Day14 | Gumboro (IBD) | Eye drop |
| Day21 | Gumboro (IBD) | Drinking water |
| Day28 | Newcastle (NCD), Infectious Bronchitis (IB) | Drinking water |
| Week6 | Fowl Pox | Wing Stab |
| Wekk8 | Fowl Typhoid | Thigh Muscle |
| Week18 | Dewormer | Drinking water |

Then vaccinate NCD / IB after every 2 months

**Example more elaborate vaccination schedule backyard chickens**

| Day | Vaccines | Method |
|---|---|---|
| 0 | Marek's, Gumboro (IBD) | Inject hatchery |
| 0 | Newcastle (NCD), Infectious Bronchitis (IB) | Spray hatchery |
| 10 | Gumboro (IBD) | Drinking water |
| 14 | Newcastle (NCD), Infectious Bronchitis (IB) | Drinking water |
| 18 | Gumboro (IBD) | Drinking water |
| 24 | Newcastle (NCD), Infectious Bronchitis (IB) | Drinking water |

**Example more elaborate vaccination schedule backyard**

| Day | Vaccines | Method |
|---|---|---|
| 28 | Gumboro (IBD) | Drinking water |
| 49 | Fowl Pox + Avian encephalomyelitis (AE) | Wing Web stab |
| 49 | Newcastle (NCD), Infectious Bronchitis (IB) | Intramuscular inject |
| 49 | Coryza | Subcutaneous inject |
| 56 | Newcastle (NCD), Infectious Bronchitis (IB) | Drinking water |
| 70 | Mycoplasma | Subcutaneous inject |
| 84 | Newcastle (NCD), Infectious Bronchitis (IB) | Drinking water |
| 105 | Salmonella Enteritidis and -Typhimurium | Intramuscular inject |
| 105 | Coryza | Subcutaneous inject |

## Annex: Learning objectives

At the end of the two days training, the participants are able to:

1) Describe a local poultry house to be constructed which is:
   a) Adequate in size
   b) Relative cheap
   c) Easy to clean and disinfect
   d) Easy to manage
   e) Climate resilient (cool during hot periods, warm during nights and early mornings)
   f) Bio secure
   g) Protected against rain and direct sunlight
2) Explain proper procedures for hatching egg collection, -storage, -incubation and hatching
3) Explain why it is essential to feed the chicks during the first months of their life a complete balanced feed
4) Mix commercial feed with locally available feedstuff, such as Azolla, Rice bran, Broken Rice, Larvae of black soldier flies
5) Explain why the care of chicks during their first weeks is essential for their performance during the rest of their life
6) Describe the care of chicks during their first month in relation to:
   a) Hygiene
   b) Temperature environment
   c) Ventilation
   d) Water quality
   e) Water temperature
   f) Feed
   g) Light
7) Describe typical clinical signs /characteristics of Avian Influenza, New Castle Disease, Fowl Pox, Chronic Respiratory Disease, Fowl Cholera, Salmonella, Marek's disease, Infectious Bronchitis and Coccidiosis and which treatments are applicable.
8) Explain proper procedures to maintain poultry vaccines from the moment these are purchased till the application.
9) Execute an effective vaccination with the:
   a) Drinking water method
   b) Eye-drop method
   c) Nose-drop method
   d) Wing-web method

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