Drinking Water Vaccination

Wherever possible, today's large poultry operations prefer to use mass application techniques for vaccination with live vaccines.

Even though these techniques involve application to thousands of birds at one time, the goal is the same as for individual bird vaccination: **deliver a minimum of one dose of vaccine to the target organ of each bird**. Not only does the dose of vaccine have to be adequate, but it must be alive when it reaches the birds in order to replicate and induce an immune response.

Under practical conditions our aim is to vaccinate the highest possible proportion of birds in a flock. This prevents the proliferation of a field pathogen on a farm and thus minimizes the effects of a particular disease.

Mass application through the drinking water offers the advantages of:

- Lower labor costs
- Minimal bird stress
- Stimulation of mucosal immunity.

Its main disadvantages are:

- Inconsistencies of vaccine dosage depending on water consumption.
- The potential for some birds to receive no vaccine at all.
- Incomplete coverage of the flocks can result in rolling post vaccination reaction due to repeated bird to bird transmission.

The four most common methods of delivering vaccines through water are by:

- Automatic dosing systems.
- Pumping vaccine solution from a vaccine tank into the water system.
- Pouring of vaccine solution into bell drinkers.
- Using overhead gravity flow tanks.

Although vaccination via drinking water would seem to be the least labor intensive it is certainly not the simplest and fastest method when done correctly. This is the method that requires the most mental and physical preparation in order to achieve good, uniform vaccine response in the whole flock. There are quite a few precautions that need to be taken for vaccination to be effective and reliable.

How live vaccines work

Live vaccines must replicate within the host before they can stimulate a protective immunity. They do this primarily by attaching themselves to target cells within the host and then push the cells to make identical bacteria particles. The replication of the vaccine virus/bacteria prompts the host to start a full immune response based on a combined cellular and humoral response of the immune system. This results in the production of circulating and local protective antibodies against the particular virus or bacteria. It follows therefore that three things are critical in this sequence of events:

1) **The virus or bacteria must still be alive when it reaches the host.**
2) **Sufficient live virus or bacteria particles must reach target cells to stimulate a protective response on the part of the host.**
3) **Each bird in the flock must receive sufficient live virus or bacteria particles to stimulate uniform protection since further spread of virus or bacteria within the flock cannot generally be relied upon.**

Major concerns in drinking water vaccination

Live vaccine are quite stable as long as they are in freeze dried form and stored in the refrigerator.
When the vaccines are dissolved in the drinking water the virus or bacteria can be inactivated by several factors. It follows that everything possible must be done to keep as much of the virus or bacteria contained in the vaccine alive and to ensure that all birds has the chance to consume enough vaccine.
Live vaccines are particularly susceptible to:-

1. **Ultraviolet light:** avoid exposure to sunlight
2. **Heat:** avoid prolonged exposure to high temperatures (e.g. vaccine vials left by a window). The drinking water should be fresh (8-15˚C).
3. **Heavy metals:** don't use materials or drinking water containing these. Use plastic buckets or containers for vaccine preparation.
4. **Chlorine:** Do not administer vaccines in drinking water containing chlorine (if chlorine can be smelled or tasted, the level is definitely very high).
5. **Disinfectants and detergents:** make sure that all materials are free from traces of these.
6. **Organic matter (litter, feed etc):** make sure that all materials and drinkers are clean.
7. **Moisture:** Do not use the contents of damaged vials. Don't break the seals on the vaccine vials until you are ready to prepare the vaccine.

Storage and preparing of vaccine

Live vaccines retain their quality up to the end of their shelf life when stored in a refrigerator at a temperature of 2-8ºC /35-46ºF.
The livability of the vaccines can be negatively affected when they are not kept in a well maintained refrigerator at the correct temperature.

Store vaccines in the refrigerator with the correct temperature

Correct temperature 2-8˚C/35-46˚F

Preparation of vaccine vials

Vaccine vials should be prepared in an office or on a clean bench or desk, free from residues of sanitizers or disinfectants. If these conditions cannot be met, covering the required surface with a clean paper tissue or plastic bag is adequate.
The floor of the entrance area of a shed is not acceptable for vaccine preparation because of the dirt and disinfectant residues with which vaccine vials can come into contact.
Vaccine vials should be opened under water.
Alternatively de-minerilized water can be injected into the vial to dissolve the vaccine
When opening vaccine vials hands must be clean (free of sanitizer/soap residues) or use disposable gloves.

Materials

Only clean, dedicated materials must be used for vaccination. Do not use the same bucket or measuring jug for preparing adding disinfectants to drinking water and vaccine stock solution!
Residues of disinfectants or other chemicals are capable of killing vaccine virus or bacteria at a very low level.

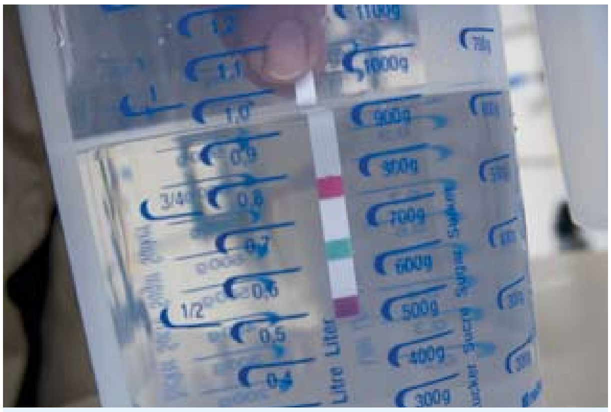
Use clean dedicated materials for preparing the vaccine

Protection from inactivation

Important issues to consider are correct handling, storage and mixing of the vaccine, however, all of these efforts can be quickly spoiled by an improperly maintained or operated water system.
Sanitizing products in the water such as chlorine, ammonia compounds or acidifiers like citric acid, together with **residual sediment (bio film) in the water lines and filters will inactivate the vaccines.** These sanitizing products and the **sediment (bio film)** in the water system can bind with or destroy vaccines. Failure to protect the vaccine may lead to partial protection of the flock.

It is advisable to check the quality of the drinking water on a regular basis. Too high (>7,5) or too low (<6,0) pH can have a negative effect on the efficacy of the vaccine virus or bacteria.
In order to test chlorine and pH levels in the water, simple testing strips are available (also used to test swimming pool water).
Chlorine **levels as low as one ppm** (1 gram per 1000 liters of water) or contamination with heavy metals can lead to **inactivation of the vaccine virus.** Oxygenated water has a strong antimicrobial effect therefore the oxygenating system should be switched off at least 48 hours before vaccination.

Testing the chlorine content of drinking water with test strips



Test strips change in color (from white to purple) when chlorine contents are higher than 1 p.p.m.

Use of stabilizer and dye in the drinking water

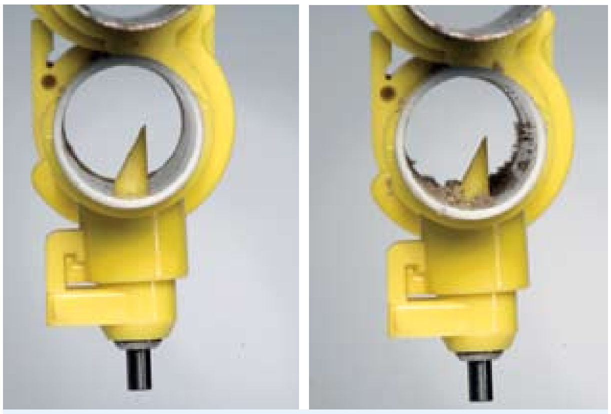
Vac-Safe

Vac-Safe is an effervescent tablet that neutralizes chlorine levels (up to 5 ppm) in the water. Vac-Safe also contains a blue dye, which makes it possible to monitor vaccine administration and distribution in the drinking water.
One tablet of Vac-Safe is required to treat up to 100 liters of water.

How to use Vac-Safe:

1. Determine the water volume needed for vaccination
2. Dissolve one Vac-Safe tablet per 100 liters of water.
3. Wait 10 minutes after adding the tablet in order to let the tablet dissolve completely and neutralize the chlorine.
4. Stir gently to mix the solution
5. Add the vaccine solution and mix it properly
6. Distribution of the vaccine in the drinking water is indicated by the presence of blue dye at the drinking nipples/ bell drinkers in the house

Dissolving Vac-Safe in a bucket for automatic dosing system



Clean and dirty nipple line

Skimmed milk/skimmed milk powder
When using skimmed milk powder it should be added at a rate of 2.0 g skimmed milk powder per liter of water or 2.0 liters of skimmed milk per 100 liters* of water. Once the milk or milk powder is added to the water it should be left to stand for 15-20 minutes (to neutralize the chlorine) before using it for reconstituting and administering the vaccine. Skimmed milk powder can form lumps which may block the drinking water system. It is therefore essential to stir the solution until these lumps disappear completely.
When skimmed milk or skimmed milk powder is used, it is not easy to see the distribution of vaccine in the drinking water. Vac-Safe tablets make the water more visible even when lights are dimmed in a shed.

*100 liters of water = 22 gallons UK, 26,42 gallons US

Vaccine tank
When using a vaccine tank to vaccinate the flock, make sure the vaccine tank is clean, free of residues. It should be possible to close the tank, preventing dirt to come into the tank. Volume calibration should be visible outside of the tank. Writing the volume levels on the outside of the tank with a marker can be a useful tool.

Automatic dosing system
Automatic dosing systems need to be cleaned and rinsed out before use. Calibrating and regular maintenance of the automatic dosing system is necessary to check if the dosing percentage is still as is set.

Filters
Filters must be removed or bypassed before vaccination. **Slime and dirt build up** on filters can concentrate undesirable disinfectants, minerals etc. on the surface of the filter, which may inactivate the vaccine.

Nipple lines
Nipple lines can become dirty due to debris that originates from the header tanks or by the build up of slime and dirt.

This slime and dirt can be caused by:
- Calcium (high hardness of water)
- Usage of different disinfectants
- Usage of vitamins, minerals and other additions in the water

Therefore it is essential to clean and sanitize these lines properly during the cleanout period using power flush and appropriate sanitizing materials.
It is also important to keep all nipple lines horizontal, since variation in the height of the line can create air blockages. This to ensure that birds have equal chance to consume vaccinated water everywhere in the shed.

Bell drinkers
If organic matter gets into the drinkers it is usually a mixture of **litter and faeces**. This ‘cocktail’ can **change the pH** of the water in the drinkers and can adversely affect the vaccine. If the flock is under medication, residues of drugs or their metabolites in the faeces can also change the pH conditions.

Shavings or other litter material can act as weight and keep the valves closed preventing vaccinated water flowing down into the drinkers.

Dirt in the drinkers can also absorb the vaccine causing it to stick to the bottom or side of the drinker bowl. A certain proportion of the vaccine thus remains in the drinker instead of being consumed by the birds. This will lead to an uneven immune response and poor flock protection. It is always advisable to clean the drinkers on the morning of vaccination **(do not use sanitizer or disinfectant.**

Distribution of vaccine
As well as problems surrounding the quality of the drinking water there are various problems linked to the extensive range of drinking water installations available. For example there are some **systems which are difficult to drain and retain substantial volumes of chlorinated water in their ‘dead spaces’.**

Bell drinkers

Emptying the water lines

Dead spaces

Depending on the type of drinker system up to 10% of the vaccinated water can remain in the dead spaces of the system and therefore remains unavailable to the birds. In certain types of header tanks there is residual water under the level of the outlet pipe. This means there is always some vaccine left in the tank once vaccination is finished. It is important to keep that in mind when planning drinking water vaccination.
The manifold of the water system can also contain substantial residual water. Residual chlorinated water in the dead space of nipple lines can be detrimental to the vaccine virus; the system must be drained completely before allowing vaccinated water to enter the drinker lines.

If drinker lines are not drained before vaccination the **residual water** in them can not only **neutralize the vaccine** but **slows down its distribution** as well.
In such cases, birds at the front of the shed may consume enough vaccinated water whilst those at the end of the shed may receive no vaccine at all. It is therefore essential to allow birds to drink only after the drinker lines have been drained and then primed with vaccinated water.

Raising the water lines

Check drinking water for blue dye indicating that vaccine solution has reached end of nippleline

Problems with cage systems

One of the difficulties associated with vaccination of caged pullet flocks is over-consumption of the vaccine solution by birds at the inlet end of the water line. Birds further down the water line may not receive vaccine solution, which results in uneven vaccination of the flock.

This can be a particularly acute problem when the flock is excessively thirsty at the time of vaccination or when the vaccine volume is insufficient.
A remedy to this problem can be to close the water system for the night, let the birds drink all the water from the lines and prime the lines with vaccinated water before lights come up in the morning. This way all the birds have an equal chance to take the vaccine as long as the header tank contains enough water for the duration of vaccination.

Depending upon the water system design, water lines of different cage batteries may not fill up at the same time. The result of this unequal filling rate is that exposure time to vaccine solution is not equal throughout the house, leading again to uneven vaccination.
Each house needs to be evaluated individually to determine the best approach towards vaccination.

Further factors affecting outcome of water vaccination

Age related problems
Vaccinating birds younger than five days old needs to be done with extra care because water intake can be irregular. This is particularly important for vaccination during the first couple of days of life.

Water consumption
Water consumption is influenced by breed, type of feed, ambient temperature, length of water withdrawal time, lighting program and type of drinker system. Guideline information can be obtained from tables in books from e.g. breeder companies, but for accurate information one needs to check water meter readings or water levels in the header tanks.

Digital water meter to measure water consumption

If in doubt a 'trial' vaccination can be done one day or two days before the actual vaccination day, to establish the volume of water consumed within the two hour period that vaccination is planned.
This way it is possible to find out the exact volume of water required for vaccination.
A 'trial' vaccination is an opportunity for detecting and rectifying any flaws in the process.

The amount of water needed for vaccination
This depends principally upon the age of the birds. Mixing the vaccine in an adequate amount of water is essential for a uniform and desired immune response. If too much water is used, birds do not consume their portion of the vaccine within the allowed time, yielding weak and inconsistent titers. If too little water is used more dominant birds or the ones nearest the drinker system over-consume leading to uneven uptake and uneven immune response among birds in the same house.

As a general rule for every 1,000 broilers, a 1,000 doses of vaccine should be dissolved in 1 to 1,5 times the liters of water as the age of the birds in days to a maximum of 40-45 liters/1000 birds.

So if a flock of 40.000 broilers is 21 days old on the moment of vaccination, you need 21 X 40 = -1260 liters of water (100 liters is 26.42 Gallons (US) and 22 Gallons (UK)

Advised water quantity needed when vaccinating broilers (1,5 liter/1000 birds)

Age (days)	No of birds (x 1000)				
	20	40	60	80	100
7	210	420	630	840	1050
14	420	840	1260	1680	2100
21	630	1260	1890	2520	3150
28	840	1680	2520	3360	4200

For **layer pullets** at an ambient temperature of 21˚C the following volumes can be used as guidelines for drinking water vaccination

Age (days)	Water intake per 1000 birds	
	Liters	Gallons (UK)
21	21	4,6
28	28	6,2
35	35	7,7
42	42	9,2
49	45	9,9

As a guide for broiler breeders the following data can be used for vaccination at 21˚C ambient temperature.

Age (weeks)	Water intake per 1000 birds	
	Liters	Gallons (UK)
2-3 wks	25	5.5
4-6 wks	30	6.6
7-10 wks	45	9.9

It is necessary to emphasize that **these volumes are guidelines only and accurate volumes need to be established on an individual flock basis.**

Adding the vaccine solution in a vaccine tank

For birds on lighting programs e.g. layer pullets or broiler breeders, vaccine may be given after a feeding and water withdrawal period or with the first water in the morning. This eliminates the need for a withholding period. The choice of method depends on management practices on a given farm.

Drinking space

We must ensure that each bird has enough drinker space to consume sufficient vaccinated water at the same time. Nipple drinkers are associated with less water wastage and also less social competition for drinking sites when birds are allowed to drink after the withdrawal period.

In the case of bell drinkers, if existing numbers are not enough to ensure adequate drinking space for all birds, (and therefore prevent uniform vaccine uptake) additional drinkers should be installed for the period of vaccination.

Advised drinking space for birds

	Bell drinkers (cm per bird)	No of birds per	
		Drink nipple	Drink cup
Rearing Birds			
Layer (floor housing)	0.6	10	12
Layer (cage housing	-	2 nipples or cups available	
Layer breeder	1	10	12
Broiler breeder	1.5	8	10
Broilers	0.6	Max 15	Max 35

If the drinker system is based on bell drinkers and the header tank cannot be used it is essential to have enough manpower on the farm to carry vaccinated water to each drinker as quickly as possible to prevent birds fighting for water and spilling vaccine.

Time of water withdrawal

As a general guideline all vaccinated water should be consumed within two to three hours.
To facilitate this, water has to be withheld from the birds for a period of time prior to vaccination.

Trial results with a blue dye in the water suggest that the ideal length of water-withdrawal for vaccination of broilers is 1-1,5 hours. This can be used as a guideline for other types of poultry also.
Ambient temperature and age must be carefully considered when establishing water withdrawal times. If birds are made excessively thirsty they will fight for the water leading to uneven uptake and spillage of vaccine.

Timing of vaccination

Vaccination early in the morning is recommended since this is when birds will exhibit peak activity, such as the first feeding period, therefore a peak water consumption can be measured.

Exposure time to vaccinated water

Two factors must be taken into consideration when determining the length of exposure time required completing successful drinking water vaccination of a flock.

First, increased exposure time to the vaccine solution gives more birds the opportunity to drink.
On the other hand the time should be limited since the titer of reconstituted vaccines generally starts to decline after two hours. Virus stability in water should be considered when developing water vaccination protocols.

Birds fighting for water

Controlling the vaccination process

To check the vaccination process, vac-safe can be used. When using Vac-Safe tablets birds that have consumed enough vaccine solution can be clearly identified.
The blue dye temporarily stains the tongue and crop of the birds.

The intensity of tongue and crop staining varies depending on the amount of vaccine solution consumed. The intensity of tongue staining is related to the protection offered by vaccination.

Newcastle Disease (ND) challenge of vaccinated birds, having different degrees of tongue staining has demonstrated that birds with more intensely stained tongues were better protected against challenge than those with lightly stained tongues.
The vac-safe can also be used in 'trial' vaccinations to evaluate vaccination technique or to check the water system.

For monitoring the distribution of vaccine in the drinking system and for neutralizing the chlorine in the water one Vac-Safe tablet per 100 liters is sufficient.
One tablet also gives staining of crop and tongue.
To gain a reasonably accurate picture about vaccine uptake, pick up 50 birds from each corner of the shed and score tongues and crops for staining.
It is best to check the birds for crop and tongue staining immediately after the vaccination.
A form to score the birds can be found in annex 2.
If vaccination has been done correctly, at least 90% of the tongues and crops will be colored blue.

Scoring crop and tongue staining in the house

Tongue staining test score +

Tongue staining test score ++

Crop staining test score ++

Vac-Safe; chlorine neutralizing tablet with dye for tongue and crop staining

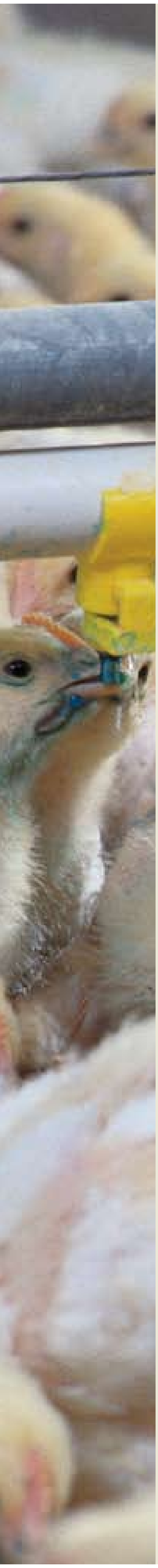
Auditing of the vaccination process

To improve the vaccination process a vaccination audit can be carried out.
Auditing will highlight which steps contribute to a successful vaccination.
Based on the audit the vaccination process can be further improved.
An example of an audit form can be found in annex 1.

Focus on the steps of successful vaccination by filling in an audit-form

Record keeping

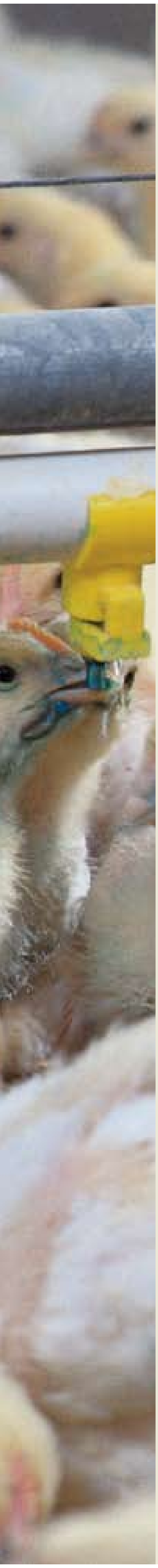
Complete the vaccination record form with name and batch number of vaccine(s) used and keep the record available for inspection.



Steps for correct drinking water vaccination

One or two days before vaccination

1. Keep vaccine refrigerated.
2. Check expiry date, batch number and type of vaccine and record this. Check if the vaccine is correct for the vaccination planned.
3. Read manufacturer's recommendations on the insert label.
4. Check the health status of the birds and only vaccinate healthy birds.
5. Make sure there are no sanitizers or acidifiers in the water system. Withdraw all medications, acidifiers and sanitizers at least 48 hours prior to vaccination.
6. Check drinking water system for dead space.
7. If using header tanks for vaccination clean them if needed and check water levels.
8. Record water meter readings for the time period you intend to vaccinate, i.e. if you want to vaccinate early in the morning, measure water intake during this period.
9. If in doubt do a trial vaccination and use Vac-Safe (blue dye) as an indicator.
10. Prepare clean materials (measuring jug, stirrer, watering can, etc.).
11. Wash troughs or bell drinkers with clean water without any disinfectant or sanitizers.
12. Test run submersible pumps or automatic dosing systems if you intend to use them.
13. If not using a header tank, fill up plastic bins/containers with the required amount of water the evening before vaccination. In this way you spare time on the day of vaccination.
14. Ensure adequate amount of Vac-Safe tablets or skimmed milk (powder) is available.
15. If you use an automatic dosing system, clean the system thoroughly before vaccination.
16. Plan timing and other details to avoid failure on vaccination day (V-day).



Day of vaccination (V-Day)

1. Turn off the main tap to the drinker system and raise the drinker lines to deprive birds of water for one –two hours. Round drinkers should be completely emptied and deprive the birds for one-two hours.

   Automatic dosing devices
   - Fill up a bucket with 0.5% - 1% of the total volume of water needed. The concentration needed depends on the automatic dosing system.
   - Mix the Vac-Safe tablets into the water. For automatic dosing systems with a 1% concentration use 1 tablet per liter water

   Water tank
   - Fill up the vaccine tank with the total water volume needed.
   - Add one Vac-Safe tablet per 100 liters of water.

2. Dim the lights and raise and drain water lines to get rid of residual chlorinated water in the system.
3. Before preparing the vaccine solution make sure your hands are clean (free of disinfectants) or use disposable gloves.
4. Prepare the right type and amount of vaccine for vaccination on a clean surface (free of residues of sanitizers or disinfectants).
5. Use clean materials to prepare the vaccine solution.
6. Remove the cap of the vaccine vials and open the vaccine vials under water
7. Rinse the vials several times to ensure that no vaccine remains in them.
8. Pour the vaccine solution into a bucket/water tank and mix the solution. After mixing put the tube of the automatic dosing system in the bucket, to prime the drinker lines (when using an automatic dosing system)
9. Prime the drinker lines with vaccinated water and let the blue- stained water reach the far end of each line. Preparation of the lines in this way ensures that birds at the far end of the lines have the same chance to drink the vaccine as birds at the front of the lines.
10. Close the end-valve of lines, lower the drinkers to bird level.
11. Increase light intensity and activate feeders.
12. Walk along the drinkers and encourage birds to go to the feeders and drinkers.
13. Check nipples/drinkers for any blockage or leakage.
14. Ensure the main tap of the water system is reopened just before the water tank runs dry to prevent air locks.
15. Rinse materials used for preparation and administration with plenty of water. Sanitizer or disinfectant must not be used for this purpose!
16. Dispose of vaccine vials following waste disposal guidelines.
17. Once used materials are dry, store them in sealed plastic bags in a clean area of the farm.
18. Complete the vaccination by writing the name and batch number of the vaccine(s) used on the house chart/vaccination schedule.

The steps and principles of this vaccination method can be adapted for any drinker system. It requires careful planning and testing to establish a farm specific vaccination protocol that can be followed by existing and future farm staff.

Final remarks

The succes or failure of vaccination depends on vaccine administration. We must keep in mind however, that we cannot achieve 100% protection by vaccination only.
Massive numbers of infectious agents are sometimes capable of breaking through the immunity of a flock.
It is thus important to implement bio-security and hygiene measures to minimize the entry and spread of pathogens to and within a farm.

Annex 1 Audit form for drinking water vaccination

Farm info

Name of farmer	
City	
Date of vaccination	
Date of audit	
Type of vaccination	
Integration name	

Technical consultant	
Veterinarian	
Type of bird	
Age in days	
Number of birds	
Name of auditor	

Flock info

Behaviour of flock	
Current treatment	Y/N
Health issues	Y/N

Vaccine info

Name of vaccine	
1/2 or full close used	
Vaccinations already carried out	
Type of storage of vaccine	

House info

Type of house	
Surface (M2)	
Lightprogramme installed	
Type of drinkwater system	
Vaccine tank present	Y/N
Automatic dosing system present	Y/N

Materials used for vaccination

Specific materials used	Y/N
Equipment checked	Y/N
Trial vaccination carried out	Y/N
Water inlet control	Y/N

Preparation of the vaccine

Vaccine solution

Expiry date of vaccine checked	Y/N
Water source (Well/Tap/mineral water)	
Liters water used per 1000 birds	
Stabiliser added for (Vac-Safe) chlorine neutralisation	Y/N
Other addition in the water (skimmed milk)	Y/N
Method opening vials	
Rinsing of vials	Y/N

In the house

Water treatment stopped	Y/N
Filters cleaned	Y/N
Water lines/through emptied	Y/N
Water system emptied	Y/N
Water system cleaned	Y/N
Visible state of water lines	dirty/clean
Previously desinfected	Y/N
Light intensity reduced	Y/N

Water with drawel

Method of waterwithdrawel	
Time of handling	
Time of thirsting birds	

Vaccination process

Number of water lines	
Numbers of refills of vaccine solution	
Length of vaccine administration	

After vaccination (tongue/crop staining)

No of birds scored	
No of points in house checked	
% of birds coloured tongue/crop	

Blood samples

No of birds samples taken	
blood samples labelled	Y/N
Storage of blood samples	

Annex 2 Crop and tongue scoring form to check drinking water vaccination

Farm ______________________ House ______________________

Date ______________________ Auditor ______________________

Starting time vaccination ________ Time vaccination finished ________ Time of tonque/crop scoring test ________

	Tongue - + ++	Crop - + ++
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

Tongue - + ++	Crop - + ++

Tongue - + ++	Crop - + ++

Tongue - + ++	Crop - + ++

Tongue score +

Crop score ++

Tongue score ++

Notes

Notes

Intervet International bv
PO box 31, 5830 AA Boxmeer
The Netherlands
Phone: +31 485 587600
Fax: +31 485 577333
E-mail: info@intervet.com
www.intervet.com

intervet
RESEARCH • PERFORMANCE • INTEGRITY