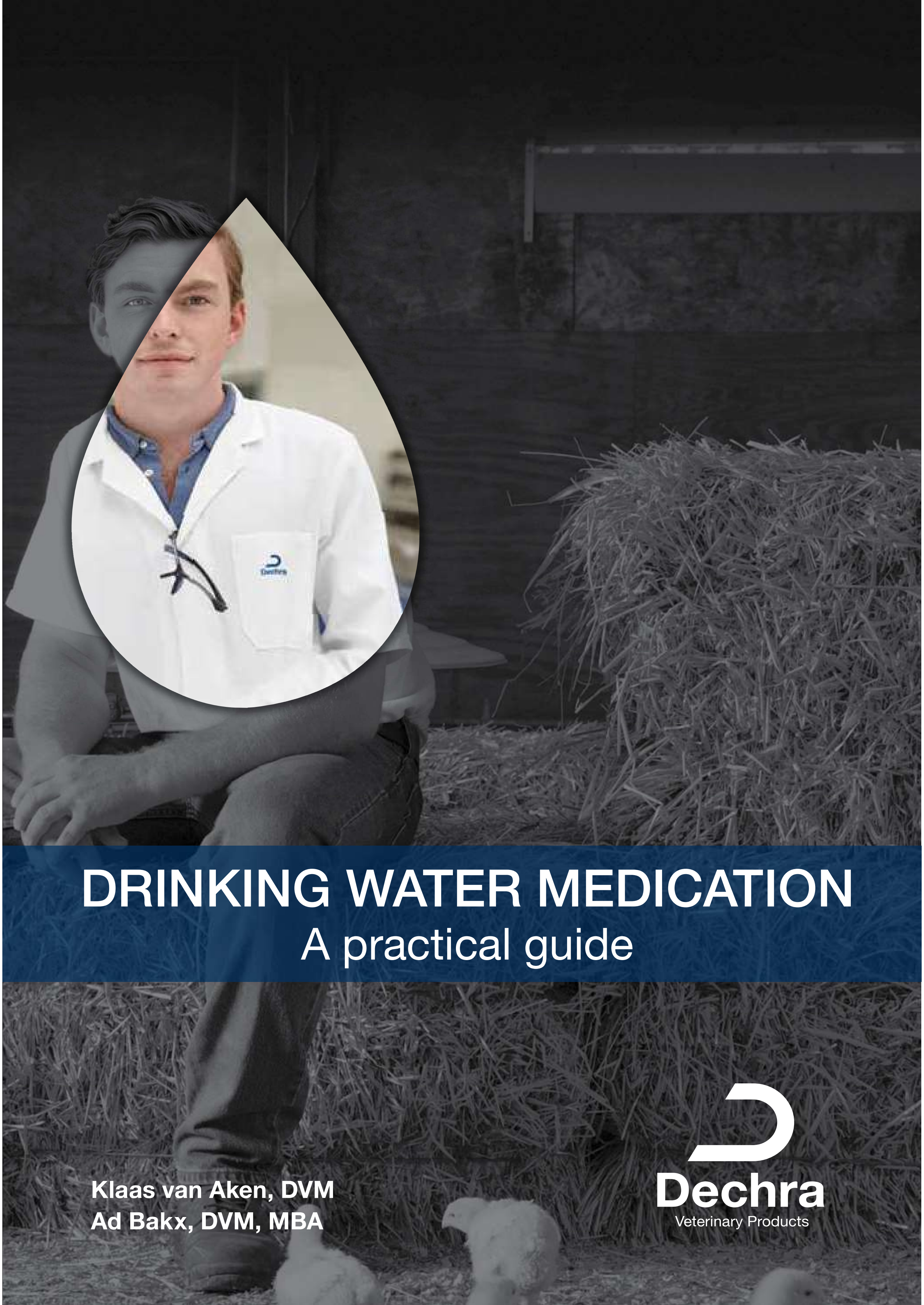

DRINKING WATER MEDICATION

A practical guide

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Dechra
Veterinary Products

Preface

The primary focus of farm management is to prevent disease. However, if animals are unwell it is crucial to start treatment as soon as possible.

A treatment method that is being used more and more with increasing farm size is water medication. Water medication is relatively easy and has major advantages in terms of starting treatment within hours of a disease being detected, flexibility of administration and following the four principal rule of responsible use of antimicrobials:

1. Treat the right animals
2. At the right time
3. With the right antimicrobial
4. In the right dose

For drinking water medication you need products that dissolve well and that are stable once dissolved. With **SoluStab®** we offer a premium range of lactose free water-soluble products with a unique formula providing an optimal balance between solubility and stability.

By using **SoluStab®** products you can achieve the correct concentrations at drinking nipple level quickly, while reducing labor costs and waste and ensuring the swift recovery of the animals.

But it takes more than this for water medication to be successful.

- Firstly, the water has to be of good quality. Because numerous parameters can interfere with medication in many ways, it is crucial that all parameters meet the chemical and microbiological standards for good drinking water.
- Secondly, the drinking water system should be well-designed and properly maintained, cleaned and disinfected.

This guide is intended for professionals who in daily practice deal with water medication (veterinarians, farm managers and farm workers). It will help them to better understand the key factors for successful water medication and to optimize management practices.

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Dechra Veterinary Products

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Notes on using the Dechra water medication and drinking water systems guide

The aim of this guide is to provide veterinary professionals with a practically useful advice on drinking water quality, the use of drinking water systems and the behaviour of antimicrobials in drinking water. The advice contained in this guide is based on a combination of literature review, clinical experience and expert contribution. We do not claim that this advice is necessarily “correct” or that it deserves greater prominence than guidance provided by other professional bodies or special interest groups. This guide is provided solely for informational purposes and is intended for use by veterinary professionals with regard to treatment of animals only.

Please note that while we have endeavoured to make sure all quoted doses are correct, users of this guide should always consult statutory texts and read the prescriptions of the products used. Furthermore, they should bear in mind that the content of this guide is based on information available to us up to July 1st, 2012. It is therefore possible that advice contained in this guide will become outdated as more research is conducted and published.

No liability is accepted for any injury, loss or damage, however caused.

Introduction

Water is important for regulating body temperature, growth and production, and for transporting nutrients and waste products within the body. To ensure good health and production levels, animals must have access to good quality drinking water.

Problems such as clogged drinking nipples and piping after administering antimicrobials usually indicate that the quality of the water in the well or the stable is poor.

Drinking water from the water company always meets the quality requirements. When a livestock breeder uses water from a well, the chemical and bacteriological properties of the water should be tested at least once per year.

In addition to contamination of the water in the well, water can be contaminated due to inadequate hygiene in drinking troughs, piping and float tanks. Hence, it is important, in addition to testing the water quality of the well itself, to also test the water quality at drinking locations, in piping and float tanks at least once per year. Also important are a thorough analysis of the drinking water system and an inventory of all drinking water supplements used until the last time the drinking water system was cleaned.

This guide covers three topics:

Part I: ‘Water quality’ stresses the importance of clean drinking water and covers amongst other sugjects water testing. An explanation is given of where the water samples should be taken and how the results of the water testing should be evaluated.
Solutions are then suggested for various problems.

Part II: ‘Drinking water systems’ explains the analysis of drinking water systems.
The entire drinking water system is thoroughly examined using flowchart diagrams.
Solutions for the various problems are presented, and a description is given of the best way to clean and maintain drinking water systems.

Part III: ‘Antimicrobials’ describes the behaviour of antimicrobials in drinking water.
The advantages and disadvantages of administering antimicrobials via drinking water are treated, as are the interactions between pharmaceutical antibiotic preparations and water parameters.

This step-by-step plan aims to give you specific advice on how to remedy and prevent problems with drinking water and drinking water medication. In result, animals should recover earlier, being both of economical and ethical benefit.

PART I DRINKING WATER QUALITY

1. Introduction

Drinking water quality is often taken for granted. While quality is certainly good in the case of tap water, the costs of maintaining this quality are increasing yearly. More and more livestock breeders are using their own sources of drinking water for their livestock, i.e. they are extracting water from the ground.

There are no legal criteria in Europe for determining the quality of drinking water for livestock. Drinking water quality, however, must meet specific criteria since animal products intended for human consumption are subject to specific requirements. Substances in the drinking water have an indirect influence on animal products intended for human consumption.

The taste of drinking water is important for good water intake. This requires the water to have good chemical and bacteriological properties. Iron (Fe > 10 mg/l) or salt (Na > 400 mg/l) levels that are too high can affect the water's taste causing the animal's water intake to be reduced. Decreased water intake can lead to reduced feed intake, and thus to **decreased yield. Especially young animals** learning to drink water are very sensitive to the taste of water.

The safety of water is assessed based on its chemical and bacteriological properties.

Chemical assessment includes:

- Nitrogen components (ammonium, nitrite and nitrate)
- Salts (sodium, chloride, sulphate)
- Minerals (calcium and magnesium = water hardness)
- Metals (iron and manganese)

The bacteriological assessment includes the total bacterial count and the number of coliform bacteria.

Animals must have adequate access to drinking water. For drinking water via drinking nipples, the height of the drinking **nipples, the number of animals per drinking nipple, the water flow rate per nipple and the accessibility of drinking nipples are important.**

2. Groundwater and tap water

The first step in finding the cause of livestock drinking water problems is determining whether a farm is using groundwater or tap water as drinking water for the livestock. If a farm makes use of water from a well, the type of purification plant used must be determined.

Water from wells (groundwater) does not always meet the quality requirements. A possible cause of bad water quality from the well is poor well construction.

If the well is poorly constructed or if the ammonium level of the groundwater is too high, the livestock breeder is advised to connect to the public water system or to have a new well drilled. Sometimes water quality can be improved by making the well deeper or shallower.

Note
Drinking water from the water company is preferred, since it always meets the quality requirements. Contamination of tap water can only occur in the animal housing as a result of inadequate hygiene in float tanks, piping and drinking troughs. Have the chemical and bacteriological properties of well water checked at least once per year.

Purification systems

If a farm uses well water, the water must be purified using a purification system.
The type of purification plant depends on the parameters that must be removed from the water.

Possible purification systems on a farm include;
- Water softeners
- Deferrization installations
- Reverse osmosis installations

More information on these installations can be found in appendix 1 *Description of different purification processes for drinking water* and in appendix 2 *The purification process per parameter.*

Note
Have the purification installation inspected by a specialist at least once per year.

3. Drinking water test

The second step in locating the cause of problems in drinking water is testing the quality of the drinking water at various locations in the drinking water system.

The water samples taken must be subjected to a chemical test *:

- Well water **

The water samples taken must be subjected to a bacteriological test:

- Well water
- Water in the stable (piping)
- Water at the place where animals drink

* Chemical water testing in the stable and at the place where the animals drink is unnecessary, since it is accepted that water parameters (except for bacterial count) do not change much after leaving the well.

** When testing the drinking water from wells, a water sample should be taken from the first regularly used tapping point, immediately after the filters of the purification installation. Drinking water from water companies does not require chemical or bacteriological testing where it enters the stable, since it can be assumed that the quality of tap water is reliable.

The different drinking water tests are described in appendix 3 *Available drinking water tests*.

The locations where water samples are taken for bacteriological testing depend on the type of farm and the problem being addressed. Often no more than three different water samples are taken. A number of guidelines are provided below for taking water samples to be used for bacteriological testing:

1. When using float tanks on a farm, a sample must be taken from a float tank located at the end of a drinking water system, preferably a float tank located in the section and/or in a warm location. Place the closed sample container under water and loosen the lid under water. Allow the container to fill and then re-close the container under water. This prevents a sample being taken of the dust layer on the surface of the water.

2. Water samples from a drinking water point in the piglet/pig section. A sample from a drinking nipple/drinking trough should be taken from a section that obtains water from float tanks. Always take the last nipple/drinking trough in the piping system. Preferably from a section with low water flow and a high temperature (for example, recently weaned piglets/recently penned pigs). If it is not possible to take a sample directly from the nipple, disconnect the piping from the last nipple and collect the first 1 to 3 litres in a clean (white) bucket, and then take the sample from this.

3. If medication was recently administered to the pigs via the drinking water, it is recommended to also take a sample from this section. Again, take the sample from the last nipple. Indicate on the laboratory form how many days the animals no longer received medication via the water, and the medication that was last administered.

4. The quality of the drinking water in gestation crates is of major importance. The nipple for the sow is used almost continuously, while the nipple for the pigletis only used approximately ten days after birth. Four to seven days after the birth of a litter, take a sample from the nipples in the gestation crate intended for the piglets. Here again it is best to choose a nipple as far as possible into the drinking water system. By way of comparison, a sample can be taken from a nipple for the sow in the same gestation crate.

5. In the sickbay, the risk of infection is high and the flow of water minimal.

6. Many organisms grow in stagnant water, so an empty section can provide interesting water samples.

In addition to the obligatory test of the existing well, a study can be done based on problems and complaints.

Bacteriological testing of the water twice per year can reveal problems in time to deal with them effectively.

Note
In addition to the annual chemical check of the well, also check the bacteriological quality of the water in the drinking water system.

Each laboratory has its own protocol for taking samples. Sometimes the livestock breeder may take the samples and send them to the laboratory. In most cases, a specialist comes to the farm to take the water samples.

Note
Have the water samples taken by a certified expert. This ensures that the samples are taken and treated properly.

4. Quality of livestock drinking water

The third step in the step-by-step plan is assessing the drinking water samples that were tested.

The table below: Drinking water standards for pigs and poultry, contains the normal and critical values used by the (Dutch) Animal Health Service when assessing the suitability of drinking water. Check the results of the water samples against the following table:

Table: Drinking water standards for pigs and poultry**

Parameter	Pigs*		Poultry	
	good	abnormal	good	abnormal
pH	5 - 8.5	<4 and >9	5 - 8.5	<4 and >9
Ammonium (mg/l)	<1.0	>2.0	<1.0	>2.0
Nitrite (mg/l)	<0.10	>1.00	<0.10	>1.00
Nitrate (mg/l)	<100	>200	<100	>200
Chloride (mg/l)	<250	>2000	<200	>2000
Sodium (mg/l)	<400	>800	<100	>200 (1)
Sulphate (mg/l)	<150	>250	<150	>250
Iron (mg/l)	<0,5	>10,0	<0,5	>5,0
Manganese (mg/l)	<1,0	>2,0	<0,5	>1,0
Hardness (°D)	<20	>25	<15	>20
Hydrogen sulphide	not detected		not detected	
Coliform bacteria (cfu/ml)	<100	>100	<100	>100
Total bacterial count (cfu/ml)	<100.000	>100.000	<100.000	>100.000

* Can also be used on horses and other monogastric animals
(1) for laying hens: > 400 mg/l sodium

Source: Animal Health Service (Netherlands)

** The 'good' columns contain the values for which the animal species in question experiences no negative effects. The 'abnormal' columns contain the limits at which the animal species in question experiences negative effects.

If parameters other than those included in table Drinking water standards for pigs and poultry, play a role with respect to the problems, the drinking water standards for human consumption are applied.

Interpreting the water test

In addition to a conclusion, some labs also give advice to the livestock breeder based on the results of the water testing, for example concerning improvements that could be made.

Possible contamination of the water with heavy metals and/or organic compounds (agricultural chemicals) is not tested.

If the water is characterized as 'less suitable ", it does not directly mean that the water is harmful, but that the quality of the well water compared to the quality of tap water is not optimal. The water can only be assessed in order to serve as drinking water for livestock. Assessing the water for human consumption is beyond the scope of investigation. The use of the tested water for human consumption is at your own risk.

Drinking water is rejected as 'fit for use in livestock':

1. If one or more parameters are above the level indicated in the column 'abnormal' in the table Drinking water standards for pigs and poultry.
2. If three or more parameters are between the standard norm and abnormal values of Table 1.

If all parameters have levels below the level 'good' the water is always seen fit for livestock consumption.

The parameters in drinking water do not influence each another, yet specific combinations can occur:

- If nitrite is present in the water, ammonium or nitrate will also be present depending on the amount of oxygen in the water.
- Manganese in water is always accompanied by iron.
- A high sulphate content is always accompanied by high levels of hardness.

5. Problems and solutions concerning parameters in drinking water

The fourth step in the step-by-step plan is addressing the drinking water's quality problem.

A detailed description of the various purification processes for drinking water is included in appendix 1 *Description of different purification processes for drinking water*.

5.1 Hardness values

Hardness up to 25°D is suitable for drinking water intended for pigs and broilers.
However, problems in the drinking water system can already manifest themselves at a hardness of 15°D. The lower limit for water hardness is set at 4°D. A general description of water hardness is given in appendix 4 *General parameters*. If the drinking water test shows that the water has an abnormally high level of hardness, this can cause calcium deposits in the drinking water system.

There are different levels of calcium deposits:

- The presence of calcium in drinking water is already a cause of deposits in the drinking water system.
- Heating water with high levels of hardness increases calcium deposits in the drinking water system.
- Calcium and magnesium in the water form complexes with various antimicrobials (such as tetracyclines). These complexes can clog the drinking nipples. More information on antimicrobials in drinking water can be found in Part III: Antimicrobials.

Appendix 5 *Problems with parameters* further explains the different levels of calcium deposits.

Problems with calcium deposits increase as the water hardness increases. The formation of calcium deposits might give the impression that the complete absence of substances such as calcium and magnesium would be desirable (soft water). Soft water, however, also erodes piping, hence the lower limit for hardness is set at 4°D. Iron for example tends to dissolve in soft water, which also has negative consequences for piping.

Note
The ideal level of hardness is between 13 and 17 °D. Within these limits, calcium deposits are minimal and corrosion problems are avoided.

Consequences of calcium deposits

Calcium deposits in the drinking water system decrease the flow of drinking water by reducing the diameter of the piping and the drinking water openings.

Possible consequences of poor drinking water flow are:

1. A decrease in the amount of drinking water available to the animal.The animal will not have access to the amount of drinking water it needs. Decreased water intake can lead to reduced feed intake, decreasing yield in the process. A protracted shortage of water can lead among others to dehydration in the animal.

2. Clogged drinking nipples.

   - Calcium in the drinking water comes in contact with oxygen from the air at the nipple. This can lead to calcium oxide (CaO) deposits on the outside of the nipple, causing the nipples to stick or become clogged.

   - A reduced flow of drinking water in the piping also reduces the flow of drinking water in the nipples. Since the opening in a drinking nipple is much smaller than the piping diameter, drinking nipples tend to become plugged by calcium deposits before the water piping itself.

3. The development of bacteria and other harmful substances in the piping. The reduced flow of water gives bacteria a greater chance to form into colonies. Calcium deposits roughen the surface of the piping, so bacteria and microorganisms can easily attach to the surface, which also promotes the formation of bacteria colonies. Bacteria colonies and microorganisms in the drinking water system restrict the piping diameter, resulting in a decreased flow of drinking water, and finally in blockage/ silting up. The presence of bacteria and microorganisms in drinking water also increases the likelihood of disease in the animals, resulting in turn in decreased yield.

Hardness of 20°D and higher affects the taste of water. Animals, however, are able to adjust to this taste. Water intake decreases only at a hardness of 25°D. For poultry, a limit of 20°D is recommended due to complex formation of calcium and magnesium with antimicrobials.
When medication is administered via drinking water, it is recommended to soften the water in order to limit hardness to 20°D. This, however, is not mandatory.

Note
Have the water softening installation inspected by a specialist at least once per year.
Replace or repair the water softener when water hardness is 20°D or greater. If the farm has no water softening system, one will need to be installed. After installation, clean the drinking water system as described in Part II, section 4.4 *Cleaning procedure in the case of calcium and iron deposits*.

Softening reduces water hardness to 0°D. This has no negative consequences for animal health since the feed contains sufficient calcium.
However, a hardness of 0°D can affect the quality of the piping and the pH of the water. Soft water is corrosive. When hardness decreases, so does the pH, and a low pH corrodes the piping.

Note
To prevent corrosion in the piping due to soft water, it is recommended that the soft water be mixed with hard water: 2/3 soft water to 1/3 hard water.

The most common method for softening drinking water in the livestock sector is ion exchange.
A detailed description of softening water via ion exchange is given in appendix 2 *The purification process per parameter*.

A softening installation does not require much maintenance. Parts must be replaced occasionally, and the installation must be cleaned. A softening installation is usually replaced every ten years, assuming that the installation is properly used.

5.2 Iron levels in water

Drinking water with iron levels less than 0.5 mg/l is suitable for pigs and broilers. However, iron concentrations higher than 0.5 mg/l can cause problems in piping and drinking water systems. A general description of iron levels in water is given in appendix 4 *General parameters*.

If drinking water contains too much iron, several problems can result:

a) Iron concentrations in the drinking water higher than 2.5 mg/l can clog drinking nipples. The reaction that leads to deposits is further explained in appendix 5 Problems with parameters. The red-brown iron deposit in the drinking water system decreases the flow in the drinking water by decreasing the diameter of the water piping and clogging drinking nipples. Possible consequences of poor flow in the drinking water system are a decrease in the amount of water available to the animal, clogged drinking nipples and the development of bacteria, yeasts and moulds in the drinking water system.

b) Iron concentrations above 5 mg/l make the water unsuitable for administering medication via the drinking water. Various medicines or mediums for medication (tetracyclines for example) can react with iron. When this happens, complexes are formed that deposit in the water piping. This in turn can clog drinking nipples. Some medications retain their inherent effectiveness, but cannot be absorbed by the animal due to deposits in the piping. Other medications lose their effectiveness after exposure to deposits.

c) With iron concentrations greater than 10 mg/l, the taste of iron is strong and thus livestock drink less. Decreased water intake leads to reduced feed intake, and thus to decreased yield.

d) Iron concentrations greater than 30 mg/l can cause diarrhoea in livestock. Sick animals eat less and, in the case of protracted illness, also drink less. Both cases result in reduced yield.

e) Water containing iron promotes the growth of so-called ‘iron bacteria’ (also called ‘crenotrix’). Iron bacteria very quickly develop into large bacteria colonies that attach to the water pipes and decrease the flow of drinking water. If iron bacteria colonies dislodge from the piping, blockages in the drinking water system can result. Decaying iron bacteria give off an unpleasant odour in the water. Iron bacteria absorb iron (Fe^{2+}) and convert it to hydrated iron hydroxide (deposits).

Note
Have the deferrization installation checked by a specialist at least once per year. Replace or repair the deferrization installation when iron levels in the water are too high. If the farm has no deferrization installation, one will need to be installed. After installation, clean the drinking water system as described in Part II, section 4.4 *Cleaning procedure in the case of calcium and iron deposits*.

A description of the process of deferrization is given in appendix 2 *Purification processes* per parameter. A deferrization installation is the most common type of water treatment used in livestock breeding. A well-maintained deferrization installation has a life of approximately 10 years.

5.3 Manganese levels in water

Higher concentrations of manganese result in problems in the drinking water installation over time. To avoid these problems in the piping and/or drinking water system, the water should contain less than 0.05 mg/l of manganese.

Suitable manganese levels in drinking water would be less than:

- 1.0 mg/l for pigs
- 0.5 mg/l for broilers

A general description of manganese levels in water is given in appendix 4 General parameters. If the drinking water test shows that the water has abnormally high levels of manganese, this can point to a problem: corrosion of the water pipes and the drinking water system.

There are different levels of manganese deposits:

a) Water with manganese levels above 2.0 mg/l can corrode stainless steel and form deposits due to a reaction with oxygen in the water. Appendix 5 Problems with parameters further explains the reactions between manganese and stainless steel, and between manganese and oxygen.

b) High manganese levels in water can corrode piping, resulting in leaks in the drinking water installation. It remains unclear which materials are affected by manganese and in which way.
   - Leaks result in wet places in the stables. Especially poultry are very susceptible to the quality of stable litter. Poor quality stable litter results in increased disease and production losses in chickens.
   - Leaks and the resulting lost water can also decrease the amount of drinking water available to animals. Decreased water intake leads to reduced feed intake, and thus to decreased yield.

c) Damage to the piping from high manganese levels roughens the surface on the inside of the piping. Bacteria and microorganisms can easily attach and develop on a rough surface, causing blockages in the drinking water system.

d) Manganese causes a worsening in the taste and smell of water. Decreased taste and smell result in reduced water intake, leading in turn to reduced feed intake. And decreased feed intake results in decreased yield.

High manganese levels in the drinking water system can cause problems. If, however, the water pipes are adequately thick, damage to the piping by manganese can take up to ten years. Manganese can be removed from the water with a deferrization installation.

Note
Have the deferrization installation inspected by a specialist at least once per year. Replace or repair the deferrization installation when manganese levels in the water are too high. If the farm has no deferrization installation, one will need to be installed. Then clean the drinking water system as described in Part II section 4.1 *General cleaning and disinfection*.

A description of the process of removing manganese is given in appendix 2 *Purification processes per parameter*.