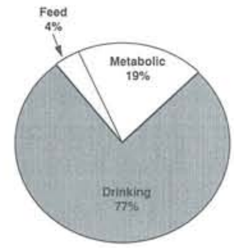
12. WATER

Like other nutrients, such as energy and essential amino acids, water is an absolute requirement in the diet of the pig. Indeed, the pig can survive much longer without energy or protein, minerals or vitamins than it can without water. This is especially true in hot weather.

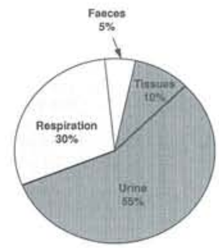
Water fulfils many functions in the pig. It provides the liquid environment that supports the movement of nutrients, waste products and hormones throughout the body. Water helps the pig maintain constant body temperature and acid-base balance, and it is a critical part of many essential chemical reactions.

Water makes up about 80% of the total body weight of the newborn piglet; this declines to about 50% in adult swine because of the lower water content in fat as compared to muscle tissue.

Pigs derive water from three sources: water physically contained in the feed, water consumed by drinking and water produced by normal metabolism in the body. Figure 12-1 illustrates typical sources and fates of water in a young growing pig; under varying environmental, nutritional and behavioural circumstances, actual values could differ significantly from this example.



Input.



Output.

Figure 12-1. Water balance in the pig: intake and output.

Requirements and Intake

The water requirements of the pig have never really been defined. In part, this is due to the assumption that pigs will drink when they need water and all that is required is an adequate delivery system. There seemed little point in spending money on research that would provide little apparent economic benefit!

The relative absence of research defining the pig's requirement for water is also due to the fact that such investigations are extremely difficult, and cannot be accomplished in the same way that one defines the requirements for other nutrients. The response criteria employed for defining amino acid or energy requirements do not apply to water. Also, a wide range of environmental factors, such as temperature and diet composition (mineral levels, protein content) influence requirements.

In the absence of traditional requirements, studies of actual water intake have been used to help predict the water requirements for a given production unit. Measuring water consumption accurately is not an easy task. Simply placing a water meter in the drinker line overlooks two important problems: the amount of water wasted and the inaccuracy of most meters at very low or intermittent flow rates. Waste can represent a significant portion of total water "disappearance." With nipple drinkers, waste can reach 50% or more of intake and will be even higher when boredom or other stressors are present. Much of the earlier information published on water intake failed to measure waste and must be interpreted with great care.

Research at the Prairie Swine Centre and elsewhere has found that true, free choice water intake in young growing pigs fed ad libitum is about 2.2 to 2.8 times the intake of feed. Thus, a pig eating 2 kg of feed will normally drink at least 4.5 litres of water per day.

Additional water, to compensate for elevated environmental temperature or excess mineral or protein in the diet, or to help the pig deal with certain health problems, must be added to the above intake levels. It is difficult to define water intake at high barn temperatures, since much of the reported research measured water disappearance, which includes waste, rather than actual intake. Actual intake probably rises by only 15% to 75% in hot weather, but waste increases dramatically, such that total water disappearance from nipple drinkers might increase as much as 3- to 4-fold. Following are some of the factors that increase or decrease water consumption.

INCREASE	DECREASE
Hunger	Cold stress
Boredom	Warm water temperature
Heat stress	High mineral levels in water
Increased dietary minerals	
Moderate mineral levels in water	
Pelleted feed	

Pigs do not drink solely to satisfy their physiological need for water. They will also drink water to alleviate a feeling of hunger or boredom. The impact of "luxury" intake must not be underestimated; boredom and hunger can increase water intake many fold over basic requirements.

The obvious question relates to the importance of over-consumption. Is it a problem? For the most part, we do not believe that it is, in terms of pig health or productivity; any water consumed above requirement will be eliminated as urine. However, over-consumption does waste water and perhaps most critically, increases the cost of slurry storage and spreading. Excess water intake, and more importantly, direct water waste is a growing concern; the cost of slurry storage is rising in response to environmental concerns and the expense of spreading slurry is also increasing due to higher labour and fuel costs.

Is under-consumption a problem? There is an increasing body of data which strongly suggests that even under ad libitum conditions, pigs do not always drink as much water as they require for good health and maximum performance. Clearly, more research is needed, but the implication is that providing water free choice may not always ensure optimum intake.

Gestating Sows

Water use by gestating sows is affected by both physiological need and behavioural influences. Since dry sows are limit fed, they consume additional water to help achieve a feeling of satiety (full stomach). This additional intake has little to do with "requirements" as defined in the classical sense, but may be important to the sow's achieving an overall sense of well-being. For example, in human nutrition, it is not uncommon to recommend that people on diets consume additional water, in part to help achieve a sense of satiety.

In addition, dry sows are often housed in individual gestation stalls, where boredom is common. Sows will consume additional water, and play with drinkers more often, merely to offset this sense of boredom. This additional water intake and playing with drinkers may lead to excessively wet, dirty conditions in the barn, depending on the design of the stalls. If it is a problem, providing water in the feeding trough, rather than nipple drinkers, has proven helpful. The provision of small amounts of straw, to serve as an object of foraging, or the feeding of a bulky diet have also proven helpful in minimizing excessive drinking.

Providing water in a properly-designed trough which minimizes waste and spill is an ideal method for providing water to the dry sow. In the case of nipple drinkers, firm recommendations are not yet available, but flow rates of 0.5 L/minute will more than suffice.

Lactating Sows

All things being equal, lactating sows have the highest relative requirement for water, due to the demands of milk synthesis. Intake studies under ad libitum conditions have suggested that nursing sows will drink between 9 and 20 litres of water per day. This is a very large variation and reflects the tremendous differences one sees among animals. Well-controlled experiments, where wastage is accurately measured, reveal that the majority of sows will drink about 15 litres per day.

However, provision of water *ad libitum* may not be enough to ensure optimum intake. Drs. Fraser and Phillips at the former Centre for Food and Animal Research in Ottawa have studied water intake in newly-farrowed sows and found that litters tended to gain poorly during the first three days after birth if the sow drank less than 10 litres of water during this period. The researchers concluded that in some sows, poor early lactation performance is associated with very low water intake. This low water consumption may be a symptom of other health problems, or just a case of simple lethargy on the part of the sow. Until more information becomes available, it may be prudent to encourage sluggish sows to become active as soon after farrowing as possible to stimulate drinking and thus promote better early lactation performance. Placing nipple drinkers at different heights in the farrowing crate does not appear to alleviate the problem.

How should water be provided to the lactating sow? In early lactation, lethargy is a problem in some animals and the best way to maximize the rate of consumption is to provide water troughs. While this is not practical in most situations, placing water in the feeder for the first three to four days after farrowing, for those few sows who do not appear to be drinking or eating well, may be advised.

Beyond day three, when this initial adjustment period of early lactation has passed, nipple drinkers with flow rates between 1 and 2 L/minute, will suffice. While some recommendations exist for much higher flow rates, research at the Centre for Food and Animal Research in Ottawa suggest no such advantage exists; the only real effect is greatly increased wastage with attending problems and costs. Indeed, the few studies which have shown impaired lactation performance required flow rates well below 0.5 L/minute!

Some suggestions have been made that sows will spend no more than five to six minutes drinking water per day; this may be true for a few sows during the first two to three days after farrowing, but is clearly not the case for most sows and certainly not beyond the third day of lactation. Research has shown that sows will spend 15 minutes or more per day at the drinker.

Excessive flow rates will not only waste water, but will also result in messy crates and wet piglets. For this reason, addressing the issue of lethargic sows by adding water to the feeder for those few animals in difficulty is a more practical and economical solution.

Piglets

Recent research, again by Drs. Fraser and Phillips, suggest that piglets may require water immediately after birth. They reported that litters gaining poorly during the first one to three days after farrowing drink more water than faster growing litters. It has been suggested that when sows are not milking well, piglets may not consume enough water from their limited milk intake and might benefit from supplemental drinking water. Nipple drinkers are not adequate for newborn piglets, because the piglets take too long to find and use the drinker; a dish drinker, located in the creep area, is a better alternative. Balancing cost and convenience, portable dish drinkers may be the best choice, employing them only in newborn litters where sow milk production appears to be a problem.

Some people have asked if the provision of drinking water to very young piglets may be harmful, reducing their motivation to suckle. A number of studies have clearly indicated this is not the case. Consequently, providing water to newborn piglets, although not a common practice, is strongly recommended, especially in warm conditions where piglets lose moisture rapidly.

One common belief is that providing water to nursing piglets encourages creep feed intake. Although this may be true, studies have shown that the effect is relatively small until the pigs are four to five weeks of age.

Weanling Pigs

At the time of weaning, pigs are suddenly required to obtain all of their water from the drinker. It is not altogether clear how well the newly-weaned pig can regulate water metabolism, or select a daily intake appropriate to its needs. For example, a number of experiments have shown that water intake follows a peculiar pattern at weaning, being initially quite high, falling to a minimum at about four days post-weaning, followed by a gradual increase as feed intake rises. Surprisingly, water intake is at its lowest when scouring is typically at its worst, raising questions as to the adequacy of water intake at this time.

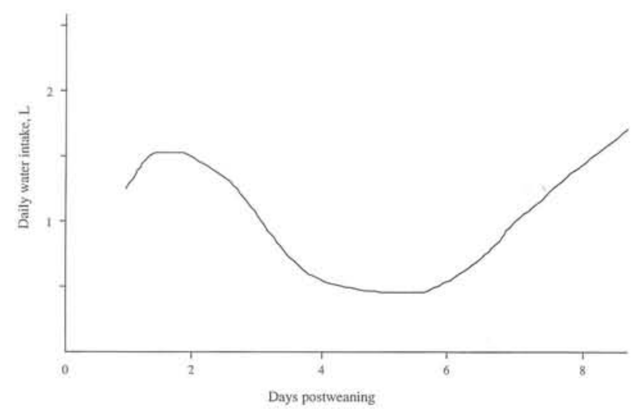


Figure 12-2. Typical Water Intake Pattern During the Post-weaning Period.

Water Delivery

Nipple drinkers are by far the most common method of providing water to pigs. They are of relatively low cost, easy to maintain and generally free of fouling. However, nipple drinkers do have their problems. They encourage waste and cannot be easily monitored; often, it will be many hours or even days before a plugged drinker is noticed, if daily checks are not observed. Nonetheless, nipple drinkers are probably the method of choice for the time being for all classes of swine except newborn piglets, where dish drinkers are clearly superior.

A relatively recent variation is the wet/dry feeder which incorporates a nipple drinker inside the feeder bowl; in some respects, they combine the features of nipple and dish drinkers. Since in some circumstances they increase feed intake, wet/dry feeders are increasing in popularity. They also reduce water wastage; a Manitoba study by Froese and Hodgkinson found that water usage was reduced by 40% with the use of wet-dry feeders.

Several studies have demonstrated that restricted nipple-drinker flow rates can impair water intake and, under severe restriction, growth rates as well. However, the flow rates must be quite low - probably below 200 mL/min. A recent survey of Saskatchewan farms revealed typical flow rates that greatly exceed this minimum (Table 12-1). These data suggest that excessive flow rates, leading to wastage, may be more of a concern than inadequate flow rates. However, individual nipple drinkers still need to be checked regularly to ensure against blockage or malfunction.

Table 12-1. Nipple Drinker Flow Rates on Saskatchewan Farms.

Location	No. farms	Ave. flow rate (mL/min)	% below 0.5 (mL/min)
Farrowing	65	1.55	4.6
Weanling	68	1.34	4.4
Growout	77	1.52	3.9

Source: 1990 Prairie Swine Centre Annual Report

The critical question for pork producers is what are the minimum and maximum flow rates necessary to optimize health and productivity? Unfortunately, research on the subject is extremely limited; in the absence of definitive experimental data, estimates are the best that can be provided. For weanlings and growers, flow rates between 500 and 1500 mL/min would appear to be satisfactory. For nursing sows, flow rates between 1000 and 2000 mL/min should cause little problem. In all cases, the major impact of excessive flow rates will be excessive wastage.

Table 12-2. Recommended Nipple Drinker Flow Rates for Various Classes of Swine.

Class of Swine	Recommended Flow Rate, mL/min[1]	
	Minimum	Maximum
Gestation	500	1,000
Lactation	1000	2,000
Weanling	750	1,000
Growout	750	1,000

[1] Estimates only, as exact ranges have yet to be completely defined.

Liquid feeding, whereby water and feed are presented to the pig as a preformed mixture, offers an alternative to separate feeders and waterers. Although the primary objective of liquid feeding is to increase feed intake, reducing water waste may be a notable additional benefit. Normally, a water:feed ratio of 2.5:1 is utilized in liquid feeding systems; this may change slightly with the make-up of the diet, the class of swine being fed and the environmental conditions within the barn.

Water Quality

There are essentially three major criteria for evaluating water quality: microbiological, physical and chemical. Within each, individual items relate to safety and/or asthetics. Canadian Federal Water Quality Guidelines appear in Table 12-3. Such standards must be interpreted with caution. Although they provide a useful general tool, they must not be considered definitive, because other factors such as the age or health status affect the response of individual animals.

Table 12-3. Canadian Water Quality Guidelines for Livestock.

Item	Maximum Recommended Limit, ppm
Major ions	
Calcium	1,000
Nitrate + nitrite	100
Nitrite alone	10
Sulphate	1,000
TDS	3,000
Heavy metals and trace ions	
Aluminum	5.0
Arsenic	0.5[1]
Beryllium	0.1[2]
Boron	5.0
Cadmium	0.02
Chromium	1.0
Cobalt	1.0
Copper (swine)	5.0
Fluoride	2.0[3]
Iron	no guideline
Lead	0.1
Manganese	no guideline
Mercury	0.003
Molybdenum	0.5
Nickel	1.0
Selenium	0.05
Uranium	0.2
Vanadium	0.1
Zinc	50.0

Source: Adapted from Task Force on Water Quality Guidelines, 1987.

The most common chemical analyses are listed in Table 12-4. Two schedules are provided: the primary test provides a useful overview and should be the first step in characterizing a water sample. If no problems are detected, there is no value in proceeding to the secondary tests, which are more comprehensive - and expensive. This approach combines economy and efficiency and helps focus attention on those issues of true importance.

Table 12-4. Assays to Include in the Chemical Evaluation of Water Used in Pig Production.

Primary Test	Supplementary Test
Total Dissolved Solids	Sulphates
pH	Sodium
Iron	Magnesium
Hardness	Chloride
Nitrates/nitrites	Calcium
	Potassium
	Manganese

All minerals elevate TDS, but only a few cause health problems; for example, calcium and magnesium contribute both to hardness and TDS, but unless present at extremely high levels or in association with sulphate, have no adverse effect on pig health. Sulphates, a major contributor to TDS in some regions, can result in severe diarrhea at even moderate levels. One can conclude that if TDS is low, the water is of good quality. If TDS is moderate to high, it may still be perfectly safe to drink, depending on what minerals are responsible. For this reason, if TDS is above 1000 ppm, the supplementary tests are required to determine if those minerals responsible for the high reading represent a significant health risk to the pig.

Total Dissolved Solids

Total dissolved solids (TDS) measures the sum of all inorganic matter dissolved in a sample of water. If less than 1,000 ppm, there is little concern. If greater than 7,000 ppm, it is unfit for swine. Between 1,000 ppm and 7,000 ppm, some farmers and veterinarians report economically relevant losses. Sometimes, the water with a high level of TDS is called "hard." This is incorrect, as hardness and a high mineral content can be quite different.

Conductivity

Conductivity may be used as a predictor of overall water quality in place of TDS. Multiplying conductivity by a constant is used to estimate TDS; however, the value of this constant differs among types of water, so that such conversions must be viewed with discretion.

pH

pH is rarely a concern because the vast majority of samples fall within the acceptable range of 6.5 to 8.5. If elevated, pH impairs the efficiency of chlorination; low pH may cause precipitation of some medications delivered via the water system. This could lead to carcass residues of these same drugs, if the precipitate is later carried in the water to pigs nearing market weight.

Hardness

Hardness is caused by multi-valent metal cations, the most abundant in groundwater being calcium and magnesium. Although it has no effect on animal health, hardness does impair the cleansing ability of water and also results in the accumulation of scale in water delivery and treatment equipment. Thus, hardness can lead to problems associated with inadequate water supply if nipples, filters, etc. become plugged. Water is considered soft if hardness is below 50 ppm; if above 300 ppm, it is deemed very hard.

Chloride

Chloride is not commonly elevated in groundwater on the Prairies. If chloride, as sodium chloride (salt), is elevated, it can be countered by adjusting the salt content of feed; this must be carried out by a qualified nutritionist to avoid problems.

Iron

Low levels of iron, as low as 0.3 ppm, can cause brownish-coloured stains in laundry and bathroom fixtures. Normally, iron in ground water exists in the soluble form; when pumped to the surface and exposed to oxygen, the iron in the water becomes insoluble. The consequence of all this is the precipitation of iron when water is pumped from the well, leading to possible blockage of the delivery system. In such cases, iron filters or a settling tank (Table 12-5) can be used to remove the iron before it becomes a problem.

Table 12-5. Effect of Aeration and Seven Days Settling on Water Chemistry (mg/L).

Item	Day	
	0	7
pH	7.92	8.06
TDS	2388	2378
Hardness	761	760
Alkalinity	408	405
Sulphates	1268	1248
Sodium	446	432
Calcium	183	189
Magnesium	75	72
Chloride	40	45
Potassium	10	11
Nitrates	1.0	1.0
Nitrites	0.3	0.3
Iron	2.5	0.6

Source: Tremblay et al., Prairie Swine Centre Annual Report, 1989.

Iron in the water can also support the growth of iron bacteria, if the well has been contaminated; however, not all wells with iron in the water will be contaminated with iron bacteria. Iron bacteria can cause foul odours and in extreme cases, can actually plug water systems, including the well itself. Such foul odours and blockage is caused by the accumulation of dead and decaying bacteria.

Shock chlorination may solve the problem, but in many cases, the benefits are temporary and the procedure may need to be repeated on a regular basis. One method is to mix 25 L of household bleach with 900 L of water; this mixture is poured into the new well and left there overnight. If necessary, the chlorinated water can be drawn through the pipes by turning on a tap at the farthest location from the well. Such water cannot be consumed, so all waterers must be turned off until the system is thoroughly flushed the following day.

Magnesium

Magnesium sulphate, also known as Epsom salts, is undesirable in water because of associated diarrhea. Typical water analysis will not define the amount of Epsom salts present, only the amount of magnesium and sulphates present. As mentioned above, magnesium, along with calcium, is also used to calculate total hardness.

Sodium

Sodium sulphate, also know as Glauber's salts, is a laxative and cathartic agent. By themselves, magnesium and sodium normally pose little risk to the pig, but their association with sulphate is a major concern.

Manganese

Like iron, manganese can also cause staining of laundry and bathroom fixtures. The threshold level of manganese is 0.05 ppm. Like iron, manganese exists in groundwater in the soluble form and is precipitated only when pumped to the surface.

Nitrates

Many people are concerned about nitrates and nitrites in their water. For human infants, their concern is well-founded since nitrates can be a serious problem. The primary concern relates to the reduction in the oxygen-carrying capacity of the blood. Among livestock, cattle are more susceptible to the problem than pigs, because the bacteria in the rumen convert nitrate to the much more dangerous nitrite.

Nitrates are often a man-made problem. They are formed by the decomposition of organic material, and can percolate through soil and into a well at up to 1 metre (3 ft) per day! They are also persistent. Examples of barns torn down three decades earlier still causing nitrate problems have been documented.

Nitrates as well as nitrites in the water have been shown to impair the utilization of vitamin A by the pig and reduce overall animal performance. However, the levels required to affect performance were so much greater than observed in most water that there is little cause for concern under practical conditions. Although pork producers should be cognizant of the potential hazards of nitrates to livestock, they pose a greater risk to humans who consume contaminated water.

Sulphates

Sulphates are a primary source of problems associated with well water quality. Sulphates are not well-handled by the gut of the pig, resulting in diarrhea and possibly reduced performance. Weanling pigs are most susceptible, but in severe cases, even adult sows have been afflicted. Depending on the level of sulphate in the water, pigs can adapt and over a period of a few weeks, become accustomed to the water. This may explain why pigs at weaning appear to be most susceptible, since prior to weaning, they have likely consumed very little drinking water.

Impact of Water Quality

What effect does poor quality drinking water have on pigs? Diarrhea is certainly the major concern, especially in the weanling pig (adult swine may be effected in severe cases); the impact of water quality on animal performance remains controversial.

Clinical reports suggest a major impact of poor quality water on animal performance on some farms. Yet, this has not been supported by controlled research, which has consistently concluded that pigs have considerable ability to handle water of widely varying quality with no effect on performance. The observation of diarrhea associated with poor quality water has never been questioned; the impact on pig performance has.

How does one proceed? The results of experiments summarized on Tables 12-6 to 12-8 provide useful information. In the first experiment (Table 12-6), pigs received either good quality water or one of two samples obtained from local farms; in all cases, the pigs performed very well, despite the fact that sulphate was as high as 2650 mg/L.

Table 12-6. Effect of Water Quality on the Performance of Weanling Pigs Fed a Diet Containing Antibiotics.

Variable	TDS (ppm) 217	2350	4390
	Water quality, ppm		
Sulphates	83	1280	2650
Calcium	24	184	288
Chloride	8	34	70
Magnesium	15	74	88
Sodium	24	446	947
Hardness	124	767	1080
pH	8.4	8.1	8.0
Performance			
Avg daily gain, kg/day	0.43	0.43	0.44
Avg daily feed, kg/day	0.55	0.56	0.57
Feed:gain	1.28	1.31	1.30
Avg daily water, kg/day[1]	1.60	1.84	1.81
Scour score[1]	1.07	1.30	1.46

NB. Pigs were weaned at 28 days of age and immediately placed on test for 21 days; feed and water were offered free choice. Source: McLeese et al. 1991.

[1] Effect of water source significant, $P<0.05$.

In the second experiment (Table 12-7), the starter diet did not contain any antibiotic, and in this instance, the pigs on the poor quality water grew slower and less efficiently than those on the good water. Finally, when pigs were given either good or poor quality water and exposed to either a normal or chilled environment (Table 12-8), the cold stress did not appear to make the pigs more susceptible to the effects of the water. In fact, pigs actually grew better on the poor quality water, apparently due primarily to increased feed intake!

Table 12-7. Effect of Water Quality on the Performance of Weanling Pigs Fed a Diet Free of Antibiotics.

	T.D.S.	
Item	217 ppm	4390 ppm
Avg gain (kg/day)	0.418	0.360
Avg feed intake (kg/day)	0.530	0.521
Feed:gain[1]	1.33	1.47

NB. Pigs were weaned at 28 days and immediately placed on test for 21 days. Feed and water were available free choice. Source: McLeese et al., 1991
[1] Effect of water significant, $P< 0.05$)

Table 12-8. Effect of Pen Temperature and Water Quality on the Performance of Newly-weaned Pigs.

	Environment		Water Quality	
	Normal	Chilled	Good	Bad
Avg gain/day, g[1,2]	1574	1057	960	1671
Avg feed/day, g[1]	2106	2170	1848	2428
Avg water intake, g[1]	9632	7628	7382	9878
Gain: feed ratio[2]	708	366	434	639

Pigs were weaned at 28 days and immediately placed on test for 10 days. Feed and water were available free choice. Source: Maenz et al., 1993

[1] Effect of water significant, $P<0.05$
[2] Effect of environment significant, $P <0.05$

From the above, and from research conducted elsewhere, it is clear that pigs can perform very well, even in the presence of very high levels of sulphate. Interestingly, in every case, scouring was clearly related to water quality, confirming clinical observations. What may be most significant to the industry is that the presence of scouring should not be interpreted as causing impaired growth and productivity. Therefore, pork producers, veterinarians and nutritionists are cautioned to separate the effect of drinking water quality on diarrhea from that on animal performance and determine if indeed, performance is compromised. This is critical as it has a major impact on how one responds to a water quality problem. It appears to run counter to popular thought, but the results of so many experiments cannot be ignored.

Response to Poor Quality Water

In response to water problems, some changes to the diet might be warranted. These must always be carried out with great care. Following are some changes that are commonly adopted in response to water problems.

Dietary Salt Reduction or Removal

This is a common practice on farms using water containing a high mineral load. Partial removal of salt can almost always be done without fear of difficulty because most diets contain a reasonable safety margin. However, complete removal of salt from the feed must be done with great care, because removing dietary salt removes both sodium and chloride. While most water that is high in sulphate often contains high levels of sodium, the chloride content of water on the Prairies is usually very low. Consequently, removing too much salt from the feed could result in a chloride deficiency. Therefore, careful water analysis must attend any adjustment of dietary salt levels. Furthermore, if salt adjustment is employed, water analysis must be repeated on a regular basis to ensure that the mineral content of the water has not changed.

If the dietary salt is altered inappropriately and a chloride deficiency results, depressed appetite will occur. If severe, it could cause a greater production loss than the water! Interestingly, the beneficial effects of salt removal may be related to a marginal chloride deficiency which reduces feed intake and thus is "seen" to reduce diarrhea!

Lowering Nutrient Density in the Diet

Lowering diet nutrient density has proven successful in the case of the weanling pig, where the stress of weaning combined with water proves to be too much. Adding bulky ingredients, such as beet pulp or even oats or barley appears to reduce the visible signs of scouring, but also greatly reduces the growth potential of the pig. As with the case of salt removal, the cure may be worse than the disease, so such dietary changes must be carried out with caution.

Improved Animal Management

A more desirable approach would be to lessen all stresses on the pig, by improving the overall environment for the pig (drafts, humidity, crowding, disease, etc). This enables the pig to withstand the effects of the water with less impact on its health and productivity. Improving housing, for example, is generally easier than altering the make-up of the water, and would, in most cases, improve productivity.

Water Delivery

It is entirely possible that many of the problems associated with water quality are related to its delivery. Poor quality water often plugs screens in drinkers, leaves scale in pipes and generally disrupts the flow of water from the well to the animals. Poor delivery systems which actually restrict the availability of water to the animals is a serious problem on many farms.

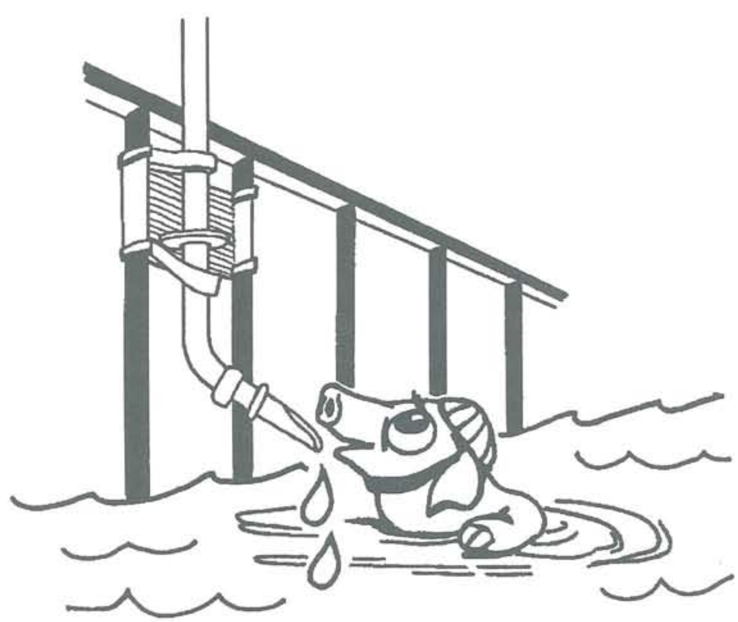
Water Treatment

If the problem is excess sulphates, treatment may not be an option due to cost. Reverse osmosis will remove sulphates, but both the capital and operating costs for a livestock unit are very high and the cost relative to benefit must be carefully balanced.

Chlorination is performed to provide disinfection and remove deleterious bacteria and other disease-causing microorganisms. It must be recognized that protozoa and enteroviruses are much more resistant to chlorination than are bacteria; it is not altogether clear if chlorination is unsatisfactory in this regard, but there is definitely cause for concern.

The effectiveness of disinfection and the quantity of chlorine required in the water will depend on the quantity of nitrites, iron, hydrogen sulphide, ammonia and organic matter content, as well as pH and temperature. For example, the higher the pH, the more chlorine must be added to achieve the same degree of disinfection. The presence of organic matter in the water converts the free chlorine to chloramines which have less disinfecting action. The length of contact will also influence the demand for added chlorine.

Water softeners of many types are available. The most common is the ion-exchange unit, which replaces calcium and magnesium with sodium. This reduces the hardness of the water, but clearly has no effect on overall mineral load. Because of sodium's role in the process, it is important to recognize that water softened in this manner will have elevated levels of sodium.



Increasing nipple flow rates does little to increase water intake in pigs but greatly increases water wastage.

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