**Water Use and Drinker Management**

**WATER USE AND DRINKER MANAGEMENT: A REVIEW**

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**Importance of Water Intake**

Water plays a number of important roles in the pig. Thermoregulation, feed intake and metabolism, urinary tract health, and behavioural disorders all interact in some way with water consumption. The result of these functions is that productivity on pig farms will suffer if adequate water intake is not achieved.

Water is used in thermoregulation, as a means of cooling through evaporation during breathing. Water intake by growing pigs doubles as environmental temperatures rise from 5 to 35 C. Water is also necessary to accommodate excesses of certain nutrients. If pigs are fed protein in excess of their lean growth potential requirements, water intake increases dramatically (Brooks, 1994). In a similar manner, if the salt content of the diet is high, water needs increase (Brooks et al., 1989). The health of animals may be adversely affected if water intake is limited. Death may occur due to ‘salt poisoning’ if pigs do not consume enough water. This most frequently occurs if water nipples become plugged or animals cannot access water because nipples are too high or difficult to trigger. The incidence of urinary tract infections is higher in sows with low water intakes (Madec, 1984).

Feed and water intake are closely related. Suckling pigs will increase water consumption if they are provided creep feed (Brooks et al., 1989), and conversely, creep feed intake will increase if water is provided (Lightfoot, 1986b). Within the nursery, when feed and water are both readily available, water and feed intake vary proportionally with each other (Maenz et al., 1993). If water intake is limited, for example by low flow rates, feed intake will decrease (Brooks et al., 1989). However, if feed intake is limited, water intake may rise as hungry pigs drink if they cannot eat (Yang et al., 1984).

**Intake vs. Disappearance**

Most studies measure the amount of water that flows through the drinker and report it as intake. Although this represents the amount of water used by the pigs, much of it is not consumed but wasted. Newborn pigs are reported to waste more than 25% of the water which disappears from their drinker bowls (Phillips and Fraser, 1990), and growing/finishing pigs may waste up to 60% of the water from a nipple drinker (Brooks, 1994). Spillage by sows varies from 23-80% of water use, depending on flow rate (Phillips et al., 1990a). Reducing the amount of spillage from drinkers would lower water and slurry costs significantly, without affecting water intake.

**Water Intake of Pigs**

Newborn piglets usually drink less than 50 ml per day, for the first few days (Fraser et al., 1988; Pedersen, 1988). Intake begins earlier, and is greater, if bowls are used. Bubbling air through the water, to attract the piglet, may increase intake to over 100 ml/day during this period. Intake gradually increases to approximately 150 mL/day by 21 days of age (Svebdsen and Andreasson, 1981). Intake increases considerably after that age (Bekaert and Daelemans, 1970), perhaps because of increased intake of dry feed (Brooks et al., 1989).

Intake in the nursery is very unpredictable for the first 5 days, and then varies with feed intake (McLeese et al., 1992). Intakes of 4 L/day during the first 2 days post-weaning, and then only 2 L/day have been reported (Pendersen, 1989). Other studies report from 0.43 to 5.5 L/day (Svendsen and Andreasson, 1981; Lightfoot, 1986b; Brooks and Carpenter, 1989). Intake is very dependent upon feed intake at this time, and excessive water is consumed until the pigs adapt to solid feed.

During the growing/finishing period, water intake increases with feed intake and body weight. Some estimates range from 1.9 to 6.8 L/day (Brooks and Carpenter, 1989). Intake, or perhaps disappearance, is greater if drinkers are used compared to wet/dry feeders (Pig International, 1994). When expressed in terms of feed intake, water consumption is approximately 3.5 L/kg of feed (Hepherd, 1981).
Estimates for water intake by gestating sows vary from 7 to 17 L/day (Brooks and Carpenter, 1989; Lightfoot, 1986a; and Madec et al., 1986). Housing conditions affect intake, with group housed sows consuming 40% less than tethered (Pig International, 1994). Intake during lactation remains at prefarrowing levels for the first day, and then increases dramatically (Lightfoot, 1986a). Estimates range from 12 to 18 L/day (Brooks and Carpenter, 1989; Phillips et al., 1990; and Pig International, 1994), but vary with litter size (Lightfoot, 1986a). However, wastage varies from 33 - 48% of disappearance, reducing intake levels to approximately 7 L/day.

Drinking Behaviour
Few studies have reported the number of drinks pigs take per day. Growing pigs have been reported to drink 36 times/day, with a total duration of 22 minutes/day (Xin and deShazer, 1991). In one study, nursery pigs spent only 3 to 4 minutes/day drinking when flow rate was low (Brooks, 1994). However, other studies with pigs as young as 10 weeks of age indicate that pigs will spend 30 minutes/day drinking.

Drinking is generally associated with meals. For pigs less than 40 kg, 85% of drinking occurs within 10 minutes of a meal. This decreases to 75% for larger pigs (Bigelow and Houpt, 1988). Pigs fed restrictively also drink intensively for the hour after feeding. Very small meals will induce over-drinking in pigs (Ingram et al., 1981), and hungry nursery pigs consume excessive amounts of water (Yang et al., 1981). Drinker-directed stereotypies (compulsive 'playing' with the nipple) may account for excessive water disappearance by stalled sows (Pig International, 1994; Bergeron, 1995).

Newborn pigs learn to drink by imitation of their littermates (Phillips and Fraser, 1990). Piglets find the water more quickly if it is in a bowl, rather than a nipple, and in as little as 14 hours if air is bubbled through the water (Phillips and Fraser, 1991). The preference for bowls continues into the growing/finishing stage, but if the bowl becomes fouled with feed, pigs will change their preference to nipples (Brooks et al., 1989). Pigs avoid drinking water that has been fouled by faeces (Pedersen, 1989). If water has a bad taste, sweet flavouring agents may improve consumption (Brooks et al., 1989).

Types of Drinkers
The means by which we provide water to pigs may be classified into five categories: valve, bowl, trough, straw, and feeder.

Valve drinkers require the pig to open the valve and drink directly from the device. Valve drinkers may be further classified as nipple, bite and button drinkers. For nipple drinkers, pigs need only move the activating 'nipple' to one side and water will flow. Bite drinkers require the pig to bite on the mechanism for activation. Button drinkers require the animal to push the activator in to open the valve.

Bowl drinkers allow the pig to drink directly from a pool of water. Water is added to the pool by a number of means. A float valve may be used to maintain a relatively constant level. Alternatively, nipple and button type valves may be used to allow pigs to fill the bowl themselves. Bowl drinkers may be hooded in order to protect the pig while it is drinking, or prevent it from fouling the water with faeces or urine.

Trough drinkers also allow pigs to drink from a pool of water, but provide sufficient space for several pigs to drink at once. They are usually mounted at floor level. Troughs are usually filled manually or by means of a float valve. However, valve type drinkers may be mounted over a trough to give pigs the options of drinking either way. Trough drinkers are commonly used for gestating sows, with water being added to the feed trough following each meal. Eating stimulates drinking, and water intake may be increased by 4 L/day if sows are fed and watered twice daily (Madec et al., 1986). Trough drinkers are also commonly used for suckling and nursery pigs, in which case they are likely to facilitate the discovery and early intake of water.

Straw drinkers require the pig to suck on a tube to draw water into its mouth from a pool (Vandenheede and Nicks, 1991). The pool is covered, to prevent fouling and spillage. Because water can only be drawn from the
tube if the pig’s mouth is sealed over the straw, spillage is virtually nil. Straw systems are more expensive than troughs, because the pool of water is enclosed. Some animals have difficulty learning to drink from straws, and it is necessary to run water through them until they do so. Although few straw systems are in use, the concept may deserve more consideration in situations in which water conservation is critical.

The final means of providing water to pigs is in the feeding system. Wet feeding, in which water and feed are mixed prior to presentation to the pig, are gaining popularity. A second feeder based presentation is via wet/dry feeders. In this case, the pig may access feed and water independently, and control the proportion of each that they consume.

Most studies on valve systems use nipple drinkers. Water spillage is generally higher with nipple drinkers than with bowls (Bekaert and Daellemans, 1970). As a result, water use is less with bowls or wet/dry feeders than with nipple drinkers (Bokma and Duijf, 1988; Pedersen, 1989, 1994; Plagge and van Leuteren, 1989). The difference in water use between bowls and nipple drinkers varies from 15 to over 30%. Use of bite drinkers, which require pigs to have their mouth properly positioned on the valve to activate it, reduces water wastage compared to nipple drinkers (Gill and Barber, 1990).

Bowl drinkers not only reduce water wastage, but also facilitate intake by suckling and nursery pigs compared with nipple drinkers (Pedersen, 1994). Pigs provided with bowls take fewer drinks, and spend less time drinking, than those using nipple drinkers. Pigs interrupt feeding in order to drink more often with nipples compared with bowl drinkers (Orban et al., 1978).

Management of Nipple Drinkers

Management of nipple drinkers is directed to ensuring adequate intake, minimal wastage, and easy maintenance. Some of the factors involved are: location, mounting angle, height, number of drinkers, and flow rates.

Standard recommendations are to mount water nipples over or at the edge of the preferred dunging area, and in close proximity to the feeder. Because more water is wasted if pigs grasp the drinker with the side of their mouth, location should encourage the pig to face the drinker (Bokma and Duijf, 1988). Mounting close to a corner, so that pigs stand against a wall while drinking is believed to accomplish this. A Swedish study reported that mounting the drinker on a short wall protruding from the side of the pen reduced water wastage by 35% (Olsson, 1983). The position required pigs to stand in the dunging area, facing toward the sleeping area while they drank. The preferred orientation of the pig facing the drinker can be encouraged by placing flanges or ‘wings’ on either side of the nipple (Gill and Barber, 1990). A farm which installed such ‘wings’ on its drinkers reduced wastage by 50%.

Most nipple drinkers are mounted horizontally or pointing downward at a 45° angle from the wall. In growing/finishing operations, nipples mounted in this fashion should be raised as pigs grow. If nipples were mounted pointing upward, at a 45° angle from the wall, there would be no need to adjust the height as all sizes of pigs would drink from floor level. Results of this mounting angle are contradictory. A Swedish study reported that such an angle reduced water waste, but that nipples frequently plugged (Olsson, 1983). An American study also found nipples plugged frequently in this position, but reported a 50% increase in waste (Carlson and Peo, 1982). There appear to be no differences in water use or waste between nipples mounted at 90° or downward at 45° (Pedersen, 1987).

The height at which the drinker should be mounted depends upon its angle and the size of the pig. For drinkers pointing straight out from the wall, the pig should drink at shoulder height. If nipples are mounted downward, pigs should lift their head slightly (Gill and Barber, 1990). The proper angle is achieved by placing the nipple 5 cm above the back of the pig, or 20% higher than shoulder height. If the drinker is higher than this level, pigs have difficulty drinking, and if it is lower, wastage is increased. The formula for drinker height (tip of drinker) for nipples installed at 90° angle, in cm, is 15 *
BW^{0.33} (kg), which is the approximate equivalent to shoulder height. The formula for drinker height (tip of drinker) for downward mounted nipples, in cm, is 18 * BW^{0.33} (kg), which is the approximate equivalent to 120% of shoulder height. Nipples should be set at a height to accommodate the smallest pig in the pen (Table 1).

Water use, and presumably water wastage, increases with flow rate (Barber et al., 1989; Nienaber and Hahn, 1984). Flow rates higher than the pig’s maximum rate of drinking result in water spillage, but we know little about maximum intake rates. The maximum intake rate for sows seems to be 1,800 mL/min (Phillips et al., 1990), but this has not been extrapolated to other age classes. If we assume that rate of intake is proportional to body weight, then the maximum rate for a 25 kg pig would be approximately 180 mL/min. Even at flow rates below maximum intake rates, wastage would be positively related to flow rate as spillage during accidental activation would be higher with fast flowing nipples. It would appear that minimal flow rates should be used, provided feed intake and gain are not affected (Barber et al., 1988; Leibbrandt, 1991; Shurson, 1989; Shurson and Sorrell, 1990). However, the level at which flow rate affects intake and gain differs among reports. The most common recommendations for flow rates are 500 mL/min in nurseries, 700 in grow/finish, 1,000 in gestation, and 1,500 for lactating sows (Brooks and Carpenter, 1989). Flow rates differ considerably among drinkers, and with water pressure within drinkers (Schulte et al., 1990; Table 2).

The general recommendation is that one nipple drinker should be provided for every 10 pigs in a pen. An American study reported reduced gain in nursery pigs if only one nipple was provided for 16 pigs. However, most recommendations also suggest that at least two nipples be provided per pen. Although this appears at first to be a precaution against the plugging of one drinker, wastage is also reduced if multiple nipples are available. This reduction is believed to be the result of less competition at the drinkers.

Management of Bowl Drinkers

Bowl drinkers should be placed over the slatted area of the pen, but not in a corner, as this results in frequent fouling of the bowl with faeces. When more than one drinker is provided, the bowls should be kept close together. Otherwise one will become fouled and will not be used. Pigs should stand in front of the bowl while drinking, and this may be accomplished by hooding the bowl.

Pigs should drink from a bowl with their head slightly lowered. If the bowl is mounted too high, the pig will bite the lip of the bowl; if too low, the risk of fouling increases. Pigs should immerse their mouth into the water to drink. It has been suggested that the height of the lip of the bowl should be 40% of the height of the smallest pig.

The number of pigs per bowl can exceed that recommended for nipple drinkers. Danish work suggests up to 30 pigs per bowl, although this may depend on the design of the drinker. Flow rate should be adequate to keep up with the drinking rate of the pig, and can exceed it without resulting in wastage. A flow rate of 1,000 mL/min seems to be adequate for growing/finishing pigs. The shape of the bowl will affect cleanliness, and should allow pigs to access all parts of the bowl, particularly areas where sediment might accumulate.

Bowls have a number of advantages over nipple drinkers. Pigs learn to drink earlier from bowls than from nipples, and this is particularly important for newborn and newly weaned pigs. Pigs waste less water from bowls than from nipples, with estimates of approximately 30-40% less water use. However, bowls are affected by fouling by faeces or feed and this will limit water intake (Pedersen, 1994). Pigs prefer clean water from bowls to that from nipples, but reverse the preference if the bowls are fouled with feed (Brooks, 1994).

Wet and Wet/Dry Feeders

Water may be pre-mixed with the feed before the mix is delivered to the pens (wet feeding) or water is provided by a nipple, bite or button type drinker in the feeder (wet/dry). Water use with wet/dry feeders is reduced by 10-15% compared with a dry feeder and bowl (van Cuyck, 1991). Wet/dry feeders also increase consumption of meal feed approximately 5%.
compared with dry feeders and a separate nipple drinker (Gonyou, 1996).

One of the more controversial management decisions to make regarding the use of wet or wet/dry feeding is whether to provide an additional source of water in the pen. If pigs are not able to control their water intake, as with wet feeding, the danger of ‘salt’ poisoning is increased. Water is necessary to clear various salts from the body, and if the feed contains high levels of salt, more water must be provided. The provision of an additional drinker when wet/dry feeders are used has been reported to increase average daily gain by 50 g (National Committee, 1992). However, the effectiveness of additional drinkers may depend upon the design of the feeders, as other reports show no increase. In general, if wet/dry feeders require pigs to drink directly from the within feeder drinker, the recommendation is to provide an additional drinker elsewhere in the pen. If the feeder allows pigs to drink from a pool of water, an additional water source does not appear to be warranted.

**Research Needs**
Recommendations for drinker height, bowl size and flow rates should be based on pig weight, according to formulae rather than weight classes. Recommendations for nipple height seem to be well established, and have been expressed using an allometric relationship between weight and shoulder height. Bowl size for various weight classes of pigs have not been documented, but appear to be at the discretion of manufacturers. Flow rate recommendations have been based on empirical studies, and not related to the body weight of the pigs. It is not known if maximum intake rate is proportional to body weight, or to some exponential of body weight. Maximum intake rate has been determined for sows (Phillips et al., 1990), but not for smaller pigs.

There have been few studies on the relative location of drinkers and feeders on feed and water intake. Several recommendations for drinker position, such as locating the drinker on a wall protruding from the side of the pen (Olsson, 1983), have not been widely adopted by the industry, perhaps because supporting evidence has been lacking. Other management suggestions, such as hooding of bowls or providing protective flanges on the sides of nipples, may also require additional supporting evidence before they are adopted.

Comparisons among different types or models of drinkers need to continue, as new designs appear regularly. It is recommended that such studies include variables that will contribute to our understanding of what contributes to the success of a design. These should include pig behaviour, water wastage, injuries to the pigs, damage to the equipment, and the need for care and maintenance.

**Conclusions**
Water is an essential need for pigs, and inadequate access to it may result in reduced feed intake, reduced production, and increased health problems. Water intake is particularly important among newborn pigs and newly weaned pigs. Inadequate intake is common at these times, and limits survival and production. Water wastage contributes to the cost of production through both supply and disposal. These costs are likely to increase and the importance of reducing wastage will become more critical in the future.
Table 1. Recommended height of nipple drinkers mounted at a downward angle.

<table>
<thead>
<tr>
<th>Weight - Smallest Pig (kg)</th>
<th>Nipple Height (cm)</th>
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</thead>
<tbody>
<tr>
<td>10</td>
<td>39</td>
</tr>
<tr>
<td>20</td>
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<tr>
<td>100</td>
<td>83</td>
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Table 2. Recommended flow rates for nipple drinkers.

<table>
<thead>
<tr>
<th>Stage of Production</th>
<th>Flow rate (ml/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery</td>
<td>500</td>
</tr>
<tr>
<td>Grow/finish</td>
<td>700</td>
</tr>
<tr>
<td>Gestation</td>
<td>1000</td>
</tr>
<tr>
<td>Lactation</td>
<td>1500</td>
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References


