factsheet
Pork Information Gateway

Water Systems for Swine

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Introduction

Water is the nutrient that is required in the largest quantity by swine. Compared to the other nutrients supplied by feed, it is the most frequently misunderstood and mismanaged nutrient. While various sources recommend that water be available free choice, most fail to offer specific recommendations as to number of drinking spaces, drinker type, delivery rates of drinkers, or to specify quality parameters.

In contemporary production facilities, decisions must be made concerning all of the above. In addition, the costs of water acquisition, and the storage and disposition of wasted water has led to an increased desire to better understand the water availability needs of pigs.

Objectives

- Detail of pigs water needs
- Document patterns of water usage
- Document what impacts water needs
- Relate water usage and manure storage
- Provide details on use of water medicators
- Provide stocking density and flow rate recommendations
- Provide details on water charting to predict performance

At birth, water accounts for 82% of the pig's empty body weight. By the time the pig weighs 240 pounds, water comprises only 51% of the empty body weight [1]. In addition to body tissue and metabolic functions, water is used for: a) the adjustment of body temperature; b) the maintenance of mineral homeostasis; c) the excretion of the end products of metabolism (particularly urea); d) the achievement of satiety (gut fill); and e) satisfaction of behavioral needs [2].

Major sources of water for physiological needs, including growth, reproduction, and lactation are water from feedstuffs, water from metabolic processes, and drinking water. As a practical matter, drinking water is the major water source [3].

Nursery and Grow-Finish

Water consumption for growing-finishing pigs has a distinct periodicity with a peak at the beginning and at the end of the feeding period when nose-operated drinkers are used. Water consumption between feeding periods peaked two hours after the morning feeding and one hour after the afternoon feeding [4]. Weaned

pigs housed under conditions of constant light, showed a diurnal pattern for water intake with higher consumption recorded from 0830 to 1700hr as compared to the 1700 to 0830hr time period [5]. Grow-finish pigs using nipple drinkers showed a large peak from 1500 to 2100hr, and a smaller peak between 500 and 1100hr [6].

Class of Swine	ml/min	Cups/min
Nursery	250-500	1-2
Grower-finisher	500-1000	2-4
Breeding herd	1000	4

Table 1. Recommended flow rates for swine drinkers

With on-farm data logging, producers are recording water usage every 5-15 minutes. Figure 1 shows the record of water usage every 5 minutes (blue lines) in three finishing facilities in Nebraska using three types of water delivery devices for a one-week period in May, 2004. Notice the distinct differences in disappearance patterns. In the top graph, water disappearance gradually increases during the day, peaking around 1800 hrs. At Farms 2 and 3, the patterns are closer to those reported by researchers [4, 6]. However, at all three farms, the peak in water usage occurred in late afternoon/early evening. These on-farm results agree with others who reported that the maximum drinking activity for grow-finish pigs occurred from 1700 to 2100 hr [7, 8]. Therefore, water delivery systems must be sized with the expectation that peak demand will occur in mid- to late-afternoon for grow-finish pigs.

The number of pigs in a group (pen) apparently influences water usage. In one study water usage was higher when pigs were housed in groups of 60 versus 20. Total drinking time per pig decreased when group size increased, even though the number of pigs per drinker was the same for both group sizes [7].

Water:feed ratios for liquid feeding systems typically range from 2.5:1 [9] to 3.5:1 [10]. Recently, water: feed ratios ranging from 1.78:1 to 2.79:1 for pigs weighing from 40 to 250 pounds and fed dry feed ad libitum have been reported [11]. The lowest reported water:feed ratios were with wet/dry feeders and bowl drinkers whereas gate-mounted nipple drinkers had the highest ratios. With similar performance, this suggests that the major cause of differences in water:feed ratios between the various drinking devices is due to differences in water wastage, not differences in the amount consumed.

Water:feed ratios decrease as pigs grow [11]. For example, in two experiments, water:feed ratios with gate-mounted nipple drinkers were 3.35:1 for 40 to 55 lb pigs, declining to 2.27:1 and 2.58:1 for 209 lb pigs. When pigs were given water only in the feeding trough using a commercially available wet/dry feeder, water:feed ratios declined from 2.11:1 to 1.50:1 and when pigs were offered water using a bowl drinker the ratios declined from 2.11:1 to 1.77:1. Recent on-farm data [M.C. Brumm, unpublished data] supports the conclusion that water:feed ratios decline as pigs grow, with a ratio as low as 1.5:1 common in facilities that use wet/dry feeders or stainless steel bowl drinkers in late finishing. Assuming similar water:feed ratios for both barrows and gilts, it follows that barrows drink more water than gilts [12] since barrows eat more feed per day than gilts in mid to late finishing [13]. Pigs fed meal diets drink more water than pigs fed pelleted diets [14], reflecting similar water:feed ratios and differences in feed conversion efficiency.

General recommendations exist for the number of pigs per drinking device [15], but research to support these recommendations is limited. Researchers using 3- to 4-week-old weaned pigs reported a slight reduction in average daily gain and an increase in weight variation within pens of 16 pigs given access to one versus two nipple drinkers for 5 weeks post weaning [16]. Generally, for groups larger than 10 pigs in a nursery and 15 -20 pigs in a grow-finish facility, a minimum of two delivery devices is recommended [15, 17].

Grow-finish pigs spent from 3-16 minutes per day at nipple drinkers when flow ranged from 1100 ml/min down to 100ml/min [18]. This suggests pigs will exert some extra effort in order to obtain water. But it is not clear at what point having to wait for drinker access or exert extra effort impairs performance.

Breeding Herd

Unlike nursery and grow-finish facilities, water usage patterns in farrowing facilities do not show a distinct pattern within a 24-hour period (Figure 2). Sow's milk is primarily water, and milk yield generally increases until a peak at approximately three week post-farrowing [19], so daily water usage parallels this pattern. Daily water intake by lactating sows ranged from 2 to 6.6 gal [20, 21].

Water usage in gestation is associated with physiological and behavioral needs. Sows consume more water when feed is restricted, a behavior attributed to

Item	12-30lb	30-75lb	75-125lb	125lb+	Breeding herd
Pigs/nipple	10	10	12-15	12-15	12-15
Height, inches	6-12	12-18	18-24	24-30	30-36

Table 2. Nipple drinker stocking and height recommendations [15].

hunger, with water for abdominal fill taken during the afternoon [22]. Restricted feeding of pigs also has been linked to polydipsia [23]. In restricted-fed sows, there was no relation between water and feed intake, and sows did not necessarily drink most of their water at meal time [24].

Several studies have documented the impact of water restriction on the health and well-being of gestating swine [25, 26]. Signs of water deficiency in trough watering systems for gestating females include [27]:

- sows drink for prolonged periods when water is available;
- sows lick or suck water from the floor;
- sows dam water in the trough with their snout to increase availability in a sloped trough system; and
- sows may have increased vaginal discharges.

Gestating sows consumed 2-4gal of water per day [20, 24, 29] although intakes as high as 7.9gal per head per day have been reported [28]. Pregnant gilts consumed 1.5-3gal per day [29, 30]. In seven Manitoba, Canada herds, daily water use for sows in gestation averaged 4.1gal/d and in lactation 9.9gal/day [31]. It has been recommended that 2.5-6 gallons of water be provided daily for nonlactating sows [15, 32, 33].

Water and Manure issues

In addition to consideration of providing for the pigs needs, decisions on water delivery devices increasingly include manure storage and land application issues [34]. Researchers have demonstrated no difference in pig performance between grow-finish pigs when water was provided in a wet/dry feeder versus when water access was via a gate-mounted nipple drinker [11]. Yet, total manure production was reduced 30% for the wet/dry feeder in a summer trial. In a winter trial, a 14% decrease in manure volume occurred with a swinging drinker versus a gate-mounted nipple drinker, and a 25% decrease in water usage when comparing a stainless-steel bowl drinker to a swinging drinker.

Production systems that store manure in deep pits under fully slatted floors are selecting drinker devices that limit the amount of water wastage (and resultant manure volume) in order to increase the amount of available manure storage capacity. Water usage is in the range of 1 gallon per grow-finish pig per day with wet/dry feeders and bowl drinkers and 1.5 gallon per pig per day with gate-mounted nipple drinkers. Manure production patterns follow water usage [11, 35].

While manure volume varies with water wastage, the amount of total nutrients (N, P, and K) in the manure does not vary. Even though there is less total volume of manure to deal with when drinkers that minimize water wastage are used, the total amount of land needed for responsible land application of the collected nutrients does not vary, just the amount applied per acre. In addition, when water wastage is minimized, the stored manure can have dry matter concentrations as high as 8-10%. This compares to manure in deep pits with nipple drinkers having dry matter concentrations in the range of 3-4%. This difference in dry matter content means different equipment may be needed to agitate, load, and apply the liquid manure depending on the drinking device.

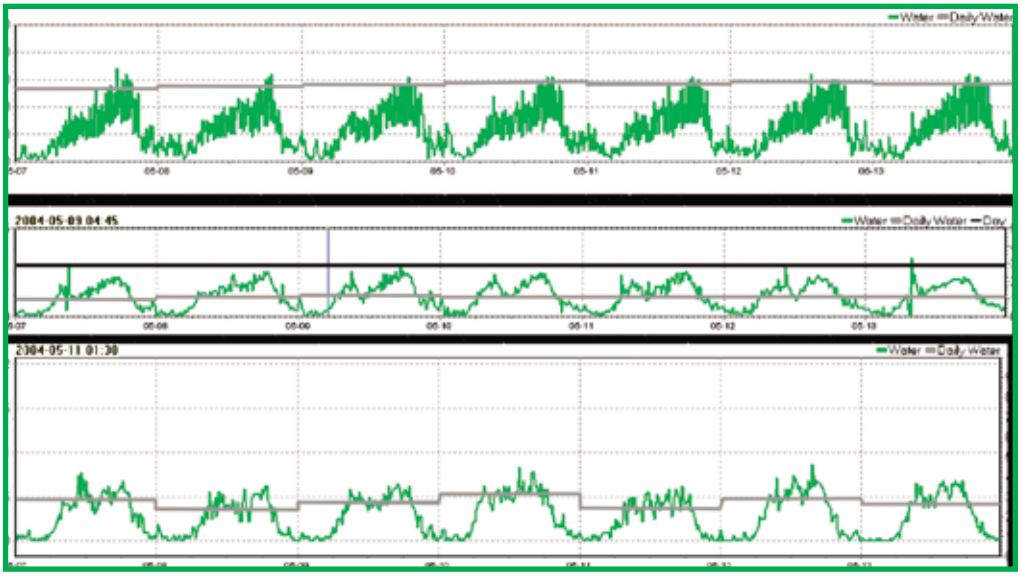

Figure 1. Water disappearance patterns recorded every 5min over a 7 d period in 3 finishing facilities with 3 different types of drinking devices (green lines). The gray line is the 24 hour accumulated total. Data courtesy DicamUSA.com.

In production systems where manure is stored in a lagoon and applied with irrigation devices, water savings

associated with drinkers are of less concern. In fact, water wastage from drinker devices may make manure flow easier through pipes to the lagoon. Moreover, the waste water contributes to a more dilute lagoon effluent, reducing the risk of odors from the manure storage device.

Pipe inside diameter, inches	Flow, gal/min at 4ft/sec
0.5	2.5
0.75	5.5
1.0	9.8
1.25	15.3

Table 3. Water flow (gal/min) from various pipe diameters (ID) assuming 4ft/sec flow and no pressure losses due to friction, elbows, etc.

Water Medication Issues

Another criteria considered in the selection of drinking devices is water medication expenses. A 50% reduction in medication expense was reported when sulfadimethoxine was administered in drinking water via bowl drinkers versus swinging nipple drinkers for a four-day period [36]. Similar data has been reported for differing types of drinkers [37]. With no differences in pig performance between drinker types, it is logical to assume that intake per pig was similar, and the difference is overall drug usage was due to wastage. Producers should not alter drug dosage dependent on type of water delivery device. An increasing number of producers who use contract nursery and grow-finish facilities are requiring facility owners to install water saving drinker devices in order to reduce drug and vaccine expenses for water-administered products.

As swine facilities house more pigs, problems related to water medication devices have increased. This is primarily due to issues associated with water medicator attachments to water supply lines. Most commercially available water medicators in the United States are equipped with a 5/8" hose bib for attachment to water supply lines. For many facilities, this means the ¾" or larger supply line must be reduced in size (and flow) at the point of medicator attachment. In some situations, producers have purchased ½" washing machine supply hoses to attach medicators, which further restricts water flow.

Flow Rate Recommendations

How fast does water need to flow from drinking devices? The drinking speed of grow-finish pigs was 1,422ml of actual water intake/min at a nipple drinker flow rate of 2,080ml/min [38]. This was a 23.2% spillage rate versus an 8.6% spillage rate when the flow was 650ml/min.

A minimum delivery rate of over 250ml/min was advised for grow-finish pigs and the rate of 1,000ml/min appears to be more than adequate [39]. Research results support the conclusion that one nipple drinker per 16-22 pigs is inadequate [39]. These results are in contrast to the conclusions that providing one versus two nipple drinkers per 20 grow-finish pigs does not affect drinking behavior, social behavior or production [7]. Flows of 70ml/minute for lactating sows decreased overall performance when compared to flows of 750 ml/min [40]. Flows as low as 70ml/min did not affect weaned pig performance [41].

Table 1 lists the recommended flow rates by class of pig for drinking devices in swine facilities. There is no data available to suggest that flow rates differ between nipple drinkers, bowl drinkers, tube feeders, etc.

In addition to flow rate, some manufacturers of wet/dry feeders recommend that water pressure be reduced to be no more than 10psi. A general recommendation is that water pressure in drinking supply lines be limited to 20psi. This makes activation of delivery devices (paddles, nipples, etc) easier and tends to reduce water wastage from drinking devices.

Number of drinkers

In Table 2 are listed the number of pigs recommended per drinker and suggested drinker height when gate-mounted nipple drinkers are utilized [15]. Note that these height recommendations are appropriate for nipple drinkers mounted at a 90° angle. When mounting brackets with 45° angles are utilized, greater heights are necessary in order for the pig to manipulate the drinker and minimize water wastage. When swinging drinkers are used, it is recommended that they be adjusted to a height of 2-3 inches above the back of the pig every 2-3 weeks as the pigs grow.

With wet/dry feeders, the general recommendation is up to 12 pigs per feeder space. There is no data available to suggest an appropriate stocking density for tube feeders or bowl drinkers. Many manufacturers recommend no more than 20-25 pigs per bowl drinker.

Water Supply Issues

In addition to drinking water needs, water must be available for cleaning and other uses. As swine facilities have grown in size, issues associated with sizing of water supply lines have become more critical.

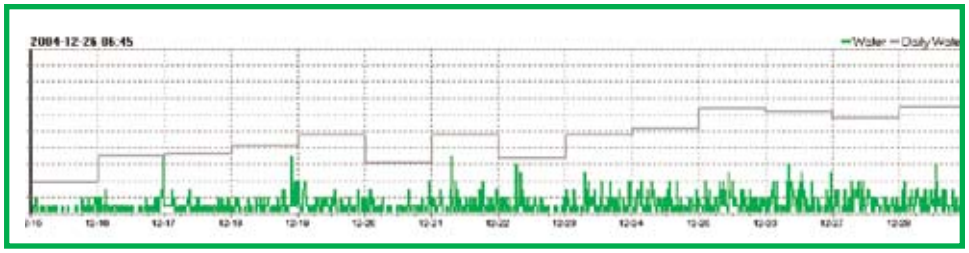

Figure 2. Water disappearance pattern in a farrowing room the first 14 d of lactation. The green lines represent water usage recorded every 5min and the gray line represents 24h total water usage. The vertical dashed lines are 0600 hr each day. Data courtesy DicamUSA.com.

For example, consider designing the water delivery system for a 1000 head finishing facility that has 20 pens on each side of a center aisle. Each pen will have two nipple drinking devices. If all of the nipples on one side of the aisle are being used at the same time, this would be 40 drinkers that must be supplied with water. Assuming 4cups/min flow from each drinker (Table 2), total water flow from the supply line would need to be 10gal/min (4 cups/min x 1gal/16 cups x 40 drinkers). If the water flow were any less than this, there is the chance that one or more drinkers would have reduced or even no flow when a pig attempted to drink.

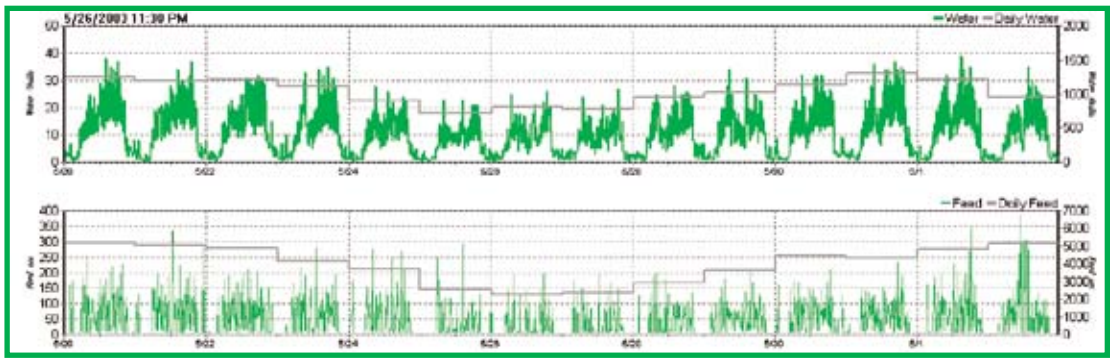

Figure 3. Water and feed patterns in a fully slatted finishing facility during a swine flu outbreak. The green lines on the bottom represent run time of the feed delivery auger in 5min increments while the gray line is the 24 h accumulated run time. Data courtesy DicamUSA.com.

Water supply lines should be sized to have friction losses less than 1psi per 100ft of pipe and flow velocities less than four feet per second [42]. This means that in order to supply 10gal per minute the pipe needs to have an inside diameter of 1 inch (Table 3).

Water as a predictor of performance

With the introduction of water recording devices, producers are becoming aware of the relationship of drinking water usage and animal health [43]. Figure 3 depicts the impact of swine flu on daily water and feed disappearance in a fully slatted finishing facility. The advantage of recording water versus trying to record feed disappearance is that if water delivery devices are well-maintained, water will generally always be available to pigs, while feed, especially in grow-finish facilities, may be limited due to empty feed bins, bridging of feed in bulk bins, or equipment failures.

Which change in the pattern of daily usage is the best predictor of pig health and performance is still unclear. Based on producer observations, when water usage drops for three continuous days, or drops more than 30% in one day, this may indicate that a potential health challenge may be occurring. These changes in usage pattern should serve as an indication to the caregiver to look more closely at the pigs that caused that pattern change for signs of illness or discomfort. A spreadsheet to create barn sheets for the purpose of charting water patterns is available at: http://porkcentral.unl.edu.

Summary

The pig will drink from a variety of devices. The amount of water needed daily by the pig depends on numerous influences, including temperature, feedstuffs, stage of production and health. Within a 24-hour period, grow-finish and gestating swine demonstrate a peak in water usage in late afternoon while lactating females consume water more consistently throughout the day. Daily water needs for pigs range from < 0.5gal/pig/day for newly weaned pigs to greater than 1.5 gal/pig/day for grow-finish pigs utilizing

nipple drinkers. Water requirements for breeding swine range from 4 gal/day for gestating females and 6gal/day for lactating swine. Appropriate water flow rates from drinking devices range from 1-2cups/min for weaned pigs to 4 cups/min for the breeding herd. Daily drinking water usage over time can be used as a predictor of swine health.

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