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WATER CONSUMPTION AND WASTE PRODUCTION DURING DIFFERENT PRODUCTION STAGES IN SWINE OPERATIONS

S. IVANOVA-PENEVA

Agricultural Institute, Shumen, Bulgaria

ABSTRACT

This study was initiated to quantify and update values used by the swine industry and regulatory authorities for water consumption and waste production for swine operations using different management practices in Bulgaria. A second objective was to apportion total water usage and total waste production into components according to the stage of production and function. The following conclusions were drawn from the data collected. Total water consumption for all production phases and functions was at average of 68,4 litres/sow/day. Half of total water consumption was 53,2% for animal drinking and a remainder (46,8%) was used for cleaning of the floor, washing and domestic use. The grow/finish production stage accounted for the highest portion of total herd use (47,7%), followed by farrowing (19,5%), gestation (18,5%) and weaned pigs (14,2%). Daily waste production rates in each production stage were very similar to daily drinking water usage rates (excluding dry cleaning sows). The grow/finish production stage accounted for the highest portion of total herd waste production (60,1%), followed by farrowing (19,1%), gestation (18,1%) and weaned pigs (16,3%). Average daily waste production rates in each phase were extremely higher than those stated in published guidelines or codes. Opportunities exist to reduce total water usage in swine operations. Most of this reduction could be achieved in the grow/finish and gestation production stages by altering management practices and focusing on water-saving drinking equipment. There is a need for a targeted research and extension effort in order to achieve immediate and substantial water usage and waste production savings in swine operations.

Key words: water consumption; waste production; swine operations

INTRODUCTION

An accurate counting of water consumption is important in today‘s expanding swine industry. As well as dictating the requirements of wells or reservoirs serving the barn, the volume of water used will influence the size of the manure storage system, and the land base required for effluent disposal or may cause problems to the environment. There are numerous current standards that quantify water requirements for hogs in different stages of production and for different types of production units. Many of these standards have remained unchanged for twenty or more years, and may not offer an accurate counting of water consumption on modern farms.

Furthermore, little information is available on the partitioning of total water use into its various components within an operation. Most published water requirement figures deal with water used for animal drinking only and fail to count a water volume for cleaning the floor, washing, cooling and other functions within a fully operational, modern production unit (Brooks et al., 1990; Fraser et al., 1990; Mroz et al., 1995). This serves to invalidate existing figures and leads to unnecessary speculation about actual total water use, particularly for large operations being scrutinized by the public. As well, this lack of information hampers efforts to focus and prioritize water conservation practices.

Correspondence: E-mail: ivanovapeneva@yahoo.com
Sonya Ivanova-Peneva, Doctor; Agricultural Institute, Department of Animal Nutrition and Technologies, 3 Simeon veliki blvd. 9700 Shumen, Bulgaria; Tel +359 54 830 448, Fax +359 54 830 455

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Table 1: Characteristics of study facilities and time of observation

Production stage	Operation type and cleaning	Days observed
Breeding/gestation sows	Individual pens, partly slatted floor	27, 29
Farrowing sows with piglets	Lifted pens, water cleaning (1)	28, 32
	Lifted pens, delta-scraper, dry cleaning (2)	22
Weaned pigs	Flat-deck cages, partly slatted floor (1)	27
	Type "Veranda", outside slatted floor (2)	17
	Individual pens, partly slatted floor(3)	15
Drow/finish pigs	Semi-open group pens with yards	periodically

Published waste production rates similarly require updating. Although the industry has through experience kept pace with increasing rates of waste production by expanding waste storage structures, these rates are often not reflected in published codes or guidelines, which are based on outdated survey data. Furthermore, little effort has been made to identify the reason and necessity for these increased waste water rates and possible measures for their mitigation.

The objectives of this study were: (1) To quantify total water consumption and waste production rates in swine operation of various management practices, and to compare these rates to published standards. (2) To apportion total water usage, drinking water and waste production by function and by production stage. (3) To identify areas of significant water wastage and quantify potential savings for both water usage and waste production.

MATERIALS AND METHODS

The study was performed in the experimental pig production station of Agricultural institute, Shumen, Bulgaria. All production stages (gestation, farrowing, nursery, and grow/finish) within a swine operations were monitored for water usage for animal drinking and water usage for cleaning of the floor of the buildings, animal cooling and washing and domestic usage. Moreover, drinking water included water requirements of pigs, and spillage during drinking, as well as when animal "plays" with water nipple and water wastage caused by damages in water system. Monitoring was arranged by dividing the drinking and the cleaning water lines (including cooling, washing, etc.) within each stage of production, and fitting each of these lines with a water meter (5 m^3 nominal water flow rate, +/-5 % error of the measurement). Records of meter readings were made every day at working days at the same time in most of the buildings and in routine intervals at finishing operation. Where possible, records of water meters were also done on the end of the production cycle of the main high pressure washing of the building when it was empty.

Different management practices in production stages, included in the study, together with the length of the water usage monitoring period, are listed in Table 1. Lactating sows, nursery pigs and weaned pigs used nipples for their drinking water source. Sows in gestation in this study received water in a feed trough rather than individual water nipples, limited time per day. At finishing pigs operation water was provided in troughs, where it was continuously running. In most of the buildings cleaning of the floor by water was provided every day.

The results were processed statistically by Microsoft Excel software, using standard procedures (Hoshman, 1998).

RESULTS AND DISCUSSION

1. Drinking water usage

Table 2 provides a breakdown of drinking water usage according to the stage of production (together with cleaning water usage). Buildings providing only partial data were excluded from this summary, only buildings providing complete data were taken into account. The grow/finish production stage accounted for the highest portion of total herd use (47,7%), followed by farrowing (19,5%), gestation (18,5%) and weaned pigs (14,2%). Dramatic variation is once again evident in the reported ranges, particularly in the gestation and farrowing stage, where an approximate seven-fold difference exists between the lowest and highest usages. A comparison of these values with other published figures is difficult, since very little information concerning total water usage by swine operations is available. Most published figures, even the recent ones, deal only with drinking water usage and wastage, and do not include water used for other functions. As a comparison of those values

Table 2: Averade daily water wastage in different production stages.

Production stage		Drinking water, L/sow/d			Cleaning water, L/sow/d			Total, L/sow/d
Breeding/gestation sows		27,2	17,1	55,3	23,4	13,8	37,6	50,6
Farrowing sows with piglets	(1)	22,2	11,9	37,7	12,1	4,5	31,6	34,3
	(2)	35,5	10,1	69,6	37,1	7,6	71,7	72,6
					Average total usage, L/sow/d			53,45
Weaned pigs	(1)	20,2	17,1	22,9	21,0	6,5	45,3	41,2
	(2)	38,7*	26,2*	69,1*	-	-	-	38,7
	(3)	37,0*	20,8*	64,3*	-	-	-	37,0
					Average total usage, L/pig/d			38,97
Grow/finish pigs		70,4	60,5	81,2	60,1	23,7	80,81	130,5

*Total water usage

obtained by this study data from other published studies are presented in Table 3. In general, the values derived from this study are considerably higher, except farrowing sows operations, which are in close agreement with most of the studies, depending on way of cleaning (Peng et al., 2006; Shaw et al., Torrey, 2008). It is seen that water consumption by farrowing sows with dry cleaning is very near to data of Pork Production Reference Guide of Canada (2000) and the precise data received in our previous studies (Ivanova-Peneva, 2003). At the same time, these data correspond well to data of American study in 7 herds, where water consumption of 37,4 L/sow/d has been measured (with variation 27,3 - 49,5 L/sow/d – Manitoba agriculture, 2001), as well as those measured in North Carolina, USA (32,0 L/sow/d - North Carolina Cooperative Extension Service, 1999). Values reported by The Netherlands reflect the aggressive water conservation techniques employed there over the past ten years, and provide an indication of what can be achieved (DGH Engineering LTD., 1999).

Gonyou (1996) reported that a large percentage of drinking water is wasted by spillage from nipple drinkers, with estimates of 60 percent wastage for growing/finishing pigs, 33 to 48 percent for lactating sows, and 23 to 80 percent for gestating sows. The equipment in this study did not employ drinkers suspended over the trough of a wet/dry feeder, instead using water nipples. This arrangement is likely to reduce wastage considerably (Gonyou, 1996).

Water requirements for nursery and growing/finishing pigs are positively related to their feed intake (NRC, 1998). For weaned pigs, this relationship has been quantified by the equation:

Daily Water Intake (L)
= 0.149 + (3.053 x daily dry feed intake, kg)

For growing/finishing pigs, voluntary water intake for pigs consuming feed *ad libitum* is approximately 2.5 kg of water for each kg of feed (NRC, 1998). Using these equations and some industry averages for

Table 3: Drinking water usage according to other published studies

Production stage	Source				
	Norms of drinking water[(1)]	Manitoba agricul-ture[(2)]	Praire Swine Centre[(3)]	North Carolina[(4)]	The Netherlands[(5)]
Breeding/Gestation (L/sow/d)	12	15.7	15,0	26,0	10,0
Farrowing (L /sow/d)	16	37,4	20,0	32,0	-
Weaned pigs (L/pig/d)	2	3,4	3,0	3,0	1,4
Grow/Finish (L/pig/d)	7	7,7	7,0	17,0	4,6

[(1)] Hinkovski, Sofia, 1982.
[(2)] Manitoba Agriculture, Nov., 2001.
[(3)] Pork Production Reference Guide, 2000.
[(4)] Water Intake of pigs, Swine News, Feb., 1999.
[(5)] The Dutch Water Consumption, research Institute for pig Husbandry, 1999.

daily feed intake, it is possible to calculate some likely wastage volumes for water usages. Average feed intakes (90 percent dry matter) for nursery pigs have been reported to be about 740 grams/day, while feed intake for growing/finishing pigs is estimated to be 90 percent of NRC values, or approximately 2.3 kg/day (Patience et al., 1995). Using these values, it can be calculated that drinking water usage should be 2.2 L/pig/day for weaned pigs and 5.8 L/pig/day for growing/finishing pigs. These values are considerably lower than the averages reported in this study (Table 2). It is likely that these differences are a reflection of enormous water wastage rather than superior feed intakes in the herds sampled.

While no quantitative relationship between daily feed intake and water intake has been established for lactating sows, it has been suggested that the majority of sows will drink about 15 litres of water per day (Patience et al., 1995). This figure is derived from studies where water wastage was minimized. Comparing this value to that reported in Table 2 would suggest a high degree of wastage (approximately 60 percent). This exceeds the rates reported by Gonyou (1996), who reported wastage rates of 33 to 48 percent for lactating sows.

Water intake for pregnant females increased in proportion to dry matter intake (NRC, 1998). Non-pregnant gilts consume 11.5 litres of water daily, and this increases to 20 litres per day in advanced pregnancy (NRC, 1998). Although these intakes are high relatively to feed intake, pregnant sows given restricted levels of feeding may compensate for inadequate gut fill by increasing their water intake (NRC, 1998). Van der Peet-Schwering et. al. (1997) suggested that a water-to-feed ratio of 2.8:1 is sufficient for pregnant sows. This would translate to a true daily requirement of 7 litres/sow/day. It is common practice to allow pregnant sows ad. lib. access to water by maintaining water in the feed trough permanently, thereby allowing excessive intake. Therefore, it is quite likely that extraneous consumption is occurring in modern gestation barns and that a reduction to a level of 12 litres/sow/day, as it was stated in our Norms of water consumption or even of 10 litres/sow/day (as experienced in The Netherlands) is realistic.

2. Waste production water usage

Waste production rates in this study were enormously higher (Table 2). In each production stage, they were very similar to daily drinking water usage rates (excepting dry cleaning sows). The grow/finish production stage accounted for the highest portion of total herd waste production (60,1%) followed by farrowing (19,1%), gestation (18,1%), and weaned pigs (16,3%). Extremely high waste production rates in this study were due to leakages from taps and nipples because of damages and not recovering them at the right time, together with frequent failures in water supply system. An other reason for excessive amounts of water used for cleaning is not keeping in the right way of the breeding technology. In dry cleaning farrowing sows no water is foreseeing for cleaning purposes, only in the end of the production cycle, but still 12 L/sow/d were used.

Table 4 dives examples how would normal usage of water should be made in pig operation unit. In general, there is a poor agreement amongst these sources as well, although those quoted by Manitoba agriculture and the Prairie Swine Centre (2000) are closest in agreement.

Reduction of water usage to requirement levels from current levels for the functions mentioned above would represent a substantial reduction in total water usage for a farrow-to-finish operation. Some of these savings are readily achievable, such as altering water dispensing practices for gestating sows. Others will require equipment modifications or changes to water dispensing devices to reduce spillage during drinking. For example, Pedersen (1999) reported that water bowls reduce water wastage by 30 percent compared to nipple drinkers. The experience gained by the pig

Table 4: Waste production rates according to other published studies

Production stage	Source				
	Norms of technolog.water[(1)]	Manitoba agriculture[(2)]	Praire Swine Centre[(3)]	USA[(4)]	The Netherlands[(5)]
Breeding/Gestation (L/sow/d)	6	15,0	15,9	3,4	9,1
Farrowing (L /sow/d)	10	30,1	21,8	10,2	13,9
Weaned pigs (L/pig/d)	6	3,4	1,6	1,1	1,7
Grow/Finish (L/pig/d)	5	7,0	8,5	4,5	3,1

(1) Hinkovski et al., Sofia, 1986.
(2) Manitoba Agriculture, Nov., 2001.
(3) Pork Production Reference Guide, 2000.
(4) Midwest Plan Service, Manure Characteristics, 2000.
(5) Research Institute for Pig Husbandry, Rosmalem, 1999.

industry in The Netherlands in achieving the above-mentioned magnitude of reduction in water usage and waste production should be further studied and evaluated for its applicability to our pig breeding industry.

The economic consequences of surplus water usage and waste production are significant. For example, direct disposal cost of the surplus effluent is approximately $17,000 (Manitoba Agriculture, 2001). This does not include the additional land required for disposal of the surplus. These costs are likely to escalate in the future.

CONCLUSIONS

Total water use for all production phases and functions averages 68,4 litres/sow/day. Half of total water use (53,2%) was for animal drinking, with the remainder (46,8%) used for cleaning of the floor, washing and domestic use.

This study identified a number of areas where significant water wastage, and hence excess waste production, were occurring. These were mainly focused on management practices. It is recommended that research organizations could investigate each of these areas in further detail to develop and demonstrate effective practices to achieve the potential savings identified. Further field monitoring of grow/finish production units for both water consumption and waste production is also recommended to obtain a larger sample size on which to base conclusions. The grow/finish phase of production appears to offer the greatest potential for significant and immediate savings in both water consumption and waste production within the industry.

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