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

Presented to:

Manitoba Livestock Manure Management Initiative Inc.

By:

DGH ENGINEERING LTD.

12 Aviation Boulevard
St. Andrews, Manitoba
R1A 3N5

Clarence Froese, B.Sc., M.Sc., P. Ag.
Doug Small, P. Eng.

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EXECUTIVE SUMMARY

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 modern management practices. A second objective was to apportion total water usage and total waste production into components according to stage of production and function.

Nine swine operations of similar design and management practices, but representing a cross section of herd sizes were selected and monitored for approximately 18 months. The following conclusions were drawn from the data collected:

- Total water use for all production phases and functions averages 89.5 litres/sow/day.
- Eighty percent of total water use was for animal drinking, with the remainder used for animal cooling (10 – 15%), washing (5 – 10%), and domestic use (1%).
- The grow/finish production stage accounted for the highest portion of total herd use (64%), followed by gestation (16%), nursery (11%), and farrowing (9%).
- Total daily water requirements were similar to published standards for gestating sows, but were significantly higher for farrowing sows, nursery, and grow/finish pigs.
- Daily waste production rates in each production stage were very similar to daily drinking water usage rates, but were significantly less than total water usage rates.
- The grow/finish production stage accounted for the highest portion of total herd waste production (66%), followed by gestation (15%), nursery (11%), and farrowing (8%).
- Average daily waste production rates in each phase were generally higher than those stated in published guidelines or codes.
- Opportunities exist to reduce total water usage by up to 50 percent in Manitoba swine operations. Most of this reduction could be achieved in the grow/finish and gestation production stages by altering management practices and focussing on water-saving drinking equipment.
- There is a need for a targeted research and extension effort to adopt altered management practices and equipment choices. Such an effort could realize immediate and substantial water usage and waste production savings.

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1.0 INTRODUCTION

An accurate account of water use is important in today's expanding hog 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. 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 account of water use 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 account for usages for washing, cooling, and other functions within a fully operational, modern production unit. 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.

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 rates and possible measures for their mitigation.

2.0 PROJECT OBJECTIVES

The objectives of this study were:

1) To quantify total water consumption and waste production rates in modern swine operations of various sizes, and compare these rates to published standards.

2) To apportion total water usage by function and by production stage within modern swine operations.

3) To apportion total waste production by production stage within modern swine operations.

4) To identify areas of significant water wastage and quantify potential savings for both water usage and waste production.

3.0 METHODOLOGY

Nine hog operations equally representing small (<500 sows), medium (501-100 sows), and large (> 1000 sows) size operations were selected as survey participants. Initial attempts were made to identify and enroll only single site farrow to finish operations on the study. However, difficulty was encountered in enrolling enough large sized, single site operations. As a result, a large size finishing only operation and a large size three site farrow to finish operation were enrolled.

The operations were all located in Manitoba except the large size three site operation, which was located in Saskatchewan. All production stages (gestation, farrowing, nursery, and grow/finish) within each operation were monitored for water usage for animal drinking, animal cooling, and washing. In addition, domestic usage was monitored as a separate variable. Monitoring was achieved by selecting two drinking and two cooling water lines within each stage of production and fitting each of these lines with a water meter (Kent model no. C700P). Where possible, water meters were also installed on the main high pressure wash line serving the entire barn and on the water line serving the staff office area. Cooperators were asked to record a meter reading at routine intervals on standard recording forms and submit the forms to DGH Engineering.

Within each room or area being monitored for water usage, cooperators were also asked to measure and record liquid levels in manure collection pits. Any changes in animal inventory or activities, such as draining the pit, were to be noted on the recording form in addition to routinely measured liquid levels. This form was also submitted to DGH Engineering for subsequent calculation of waste production rates. Copies of data collection instructions and forms are attached as Appendix A.

4.0 RESULTS and DISCUSSION

Water meter readings were obtained from eight of the nine production units in which meters were installed. The ninth unit has promised to submit readings, but none have been forthcoming at the time of writing. Only two of the nine units submitted readings as per the outlined schedule, necessitating an extension of the study to obtain additional data from the remaining herds. Five of the nine cooperating units metered all water usage functions (domestic, washing, cooling and drinking) and all production phases, while the remaining four monitored only a portion of the functions and/or phases. The length of the water usage monitoring period, together with the production phases and functions monitored, are listed by herd in Table 1.

Table 1: Characteristics of Study Facilities

	Type	Size	Location	Age	Monitoring Period	Phases Monitored	Functions Monitored
A	Farrow/Finish	275 sows	South-Central Manitoba	>15 years	534 days	G, FA, N	DR
B	Farrow/Finish	250 sows	South-Eastern Manitoba	>15 years	615 days	G, FA, N, GF	D, W, C, DR
C	Farrow/Finish	350 sows	Manitoba Interlake	10-15 years	528 days	G, FA, N, GF	W, DR
D	Farrow/Finish	550 sows	Manitoba Interlake	10-15 years	365 days	G, FA, N, GF	D, W, C, DR
E	Farrow/Finish	650 sows	Manitoba Interlake	5-10 years	349 days	G, FA, N, GF	D, W, DR
F	Farrow/Finish	1000 sows	South-Eastern Manitoba	5-10 years	573 days	G, FA, N, GF	D, C, DR
G	Farrow/Finish (partial)	1300 sows	South-Central Manitoba	< 5 years	491 days	G, FA, N	W, C, DR
I	Farrow/Finish (3-site)	2400 sows	Saskatchewan	< 5 years	no results submitted	G, FA, N, GF	W, C, DR
H	Grow/Finish	6000 spaces	Manitoba Interlake	< 5 years	574 days	GF	D, W, C, DR

Phases Monitored
G = Gestation
FA = Farrowing
N = Nursery
GF = Grow/Finish

Functions Monitored
D = Domestic
W = Washing
C = Cooling
DR = Drinking

4.1 Total Water Usage

Table 2 lists the average daily water usage for each function involving water. Only the five herds monitoring water usage for all functions are reported. Some of the older facilities do not have water cooling equipment and thus did not monitor this function. Even within this small sample, there was a wide range in water usage for each function. The water usage figures for all functions represent the sum total water usage average for the five herds. Drinking water represents the majority of the water used, with water used for cooling in the growing/finishing area accounting for the second highest total. The remaining categories were relatively minor in all herds. The herd with the highest water usage total was a large herd (>1000 sows), while the lowest total water usage was obtained by a medium-size herd (500 – 1000 sows). The largest contributing factor to differences in total water usage was the presence of water sprinklers for cooling in the grow/finish area. The two herds with the lowest total water consumption level had no sprinkling equipment, while the remaining three all had sprinklers.

Table 2: Average Daily Water Disappearance by Function in Farrow-Finish Operations

Function	Number of Herds	Total Observations	Average (per sow, L)	Range (per sow, L)
Drinking	5	5	72.3	62.5 – 82.4
Washing	5	5	3.1	1.5 – 4.3
Cooling (grow/finish) [(1)]	4	7	22.4	8.1 – 37.1
Cooling (farrowing) [(1)]	2	3	0.3	0.3 – 0.3
Domestic [(2)]	4	4	1.0	0.4 – 1.5
All Functions			89.5	71.1 – 110.0

[(1)] Extrapolated as the average per total inventoried female in the herd based on sample measurements.
[(2)] Includes all water for human usage and sow washing.

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 deal only with drinking water usage and wastage, and do not include water used for other functions. Alberta Agriculture (2000) has published values for total

water usage for different types of swine operations, and a comparison of those values to those obtained by this study are presented in Table 3. In general, the values are in close agreement, except for nursery and grow/finish operations, where the values derived from this study are considerably higher.

Table 3: Values for Total Daily Water Requirements [1] by Type of Operation and Comparison to Other Published Values

Operation Type	MLMMI Value	Alberta Agriculture
Farrow – Finish (L/sow/day)	89.5	91.0
[2] Farrow – 50 lbs. (L/sow/day)	31.6	30.0
[2] Farrow – wean (L/sow/day)	21.1	25.0
[2] Nursery (L/pig/day)	3.8	2.0
[2] Grow/Finish (L/pig/day)	11.7 (7.9)[3]	7.0

[1] Total of water required for drinking, cooling, washing and domestic use.
[2] Derived from individual production stage data in farrow-finish operations.
[3] Requirement without sprinklers for cooling.

4.2 Drinking Water Usage

Table 4 provides a breakdown of drinking water usage according to the stage of production. Herds providing only partial data are included in this summary, together with herds providing complete data. Dramatic variation is once again evident in the reported ranges, particularly in the grow/finish stage, where an approximate three-fold difference exists between the lowest and highest usages. The highest overall drinking water usage was observed in a medium-sized herd (500 – 1000 sows), while the lowest was experienced by a small herd (<500 sows). The highest usage in the growing/finishing stage was measured in the large-sized finishing operation, which had a daily usage rate of 5 L/pig greater than the next highest herd. While all operations used wet/dry self feeders, this was the only unit which also utilized an auxiliary water nipple in each pen in addition to those incorporated as part of the feeder. This type of an arrangement has been reported by Froese and Yacentiuk (1990) as resulting in a 40 percent increase in water usage, but with no corresponding benefit to animal performance. This effect is likely the main reason for the dramatically higher usage measured in this herd.

Table 4: Average Daily Drinking Water Disappearance by Stage of Production in Farrow-Finish Operations

Production Stage	Number of Herds	Total Observations	Average (L/day)		Range (L/day)	
			Per Sow	Per Pig	Per Sow	Per Pig
Breeding/ Gestation	7	10	15.7	-	11.2 – 21.2	-
Farrowing	7	13	37.4	-	27.3 – 49.5	-
Nursery	7	12	-	3.4	-	1.4 – 4.9
Grower/Finisher	6	12	-	7.7	-	4.7 – 13.9

A comparison to other published values in Western Canada, the United States, and The Netherlands is presented in Table 5. With the exception of farrowing, the values are in close agreement with those reported by the Prairie Swine Centre (2000). 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.

Table 5: Comparison of MLMMI Drinking Water Disappearance Values to Other Published Values

Production Stage	Source			
	MLMMI	Prairie Swine Centre[(1)]	North Carolina[(2)]	The Netherlands[(3)]
Breeding/Gestation (L/sow/day)	15.7	15.0	26.0	10.0
Farrowing (L/sow/day)	37.4	20.0	32.0	-
Nursery (L/pig/day)	3.4	3.0	3.0	1.4
Grow/Finish (L/pig/day)	7.7	7.0	17.0	4.6

(1) Pork Production Reference Guide, 2000.
(2) Water Intake of Pigs, Swine News, Feb., 1999.
(3) The Dutch Water Consumption, Research Institute for Pig Husbandry, 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 herds in

this study did not generally employ water nipples in growing/finishing, instead using drinkers suspended over the trough of a wet/dry feeder. This arrangement is likely to reduce wastage considerably (Gonyou, 1996). Similarly, sows in gestation in this study received water in a feed trough rather than individual water nipples. Lactating sows and nursery pigs, however, used nipples for their drinking water source.

Water requirements for nursery and growing/finishing pigs are positively related to their feed intake (NRC, 1998). For nursery 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 daily feed intake, it is possible to calculate some likely wastage volumes for water usages observed in this study. Average feed intakes (90 percent dry matter) for nursery pigs in Western Canada 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 (Swine Nutrition Guide, 1995). Using these values, it can be calculated that drinking water usage should be 2.2L/pig/day for nursery pigs and 5.8 L/pig/day for growing/finishing pigs. These values are 35% and 25% lower respectively than the averages reported in this study (Table 4). It is likely that these differences are a reflection of 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 (Swine Nutrition Guide, 1995). This figure is derived from studies where water wastage was minimized. Comparing this value to that reported in Table 4 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 increases 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 relative to feed intake, pregnant sows given restricted levels of feed may compensate for inadequate gut fill by increasing their water intake (NRC, 1998). Van der Peet et. al. (1997) suggested that a water: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 at all times, thereby allowing excessive intake. Therefore, it is quite likely that extraneous consumption is occurring in modern gestation barns and that a reduction of 33 percent to a level of 10 litres/sow/day (as experienced in The Netherlands) is realistic.

4.3 Cooling Water Usage

Water is used for evaporative cooling of lactating sows and growing/finishing pigs during warm weather and for reinforcement of dunging habits in partially-slatted grow/finish pens. Evaporative cooling of lactating sows is achieved by placement of a nozzle designed to drip on the sows' shoulders when in a standing position. These nozzles are rated to deliver 2.3 litres per hour. Cooling of growing/finishing pigs is achieved by placement of a separate water line over the slatted area of a row of pens. This line is fitted with spray nozzles (one per pen) designed to deliver 0.90 litres/minute/nozzle. Both systems are temperature activated with an adjustable activation point, commonly set at 25ºC for lactating sows and 20ºC for growing/finishing pigs. Whereas the sow dripper system operates fully on or off, the grow/finish sprinkler system can be programmed to operate intermittently with an adjustable cycle frequency and cycle length. A commonly used program in commercial operations in Manitoba and in the herds surveyed is as follows:

Room Temp.	Cycle Length and Frequency
15ºC - 25ºC	1 minute cycle every 30 minutes
25ºC - 30ºC	2 minute cycle every 30 minutes
> 30ºC	2 minute cycle every 10 minutes

This is in sharp contrast to the traditional recommendation of activation occurring only at the stage 3 ventilation set point (usually around 20ºC) and a cycle length of 30 seconds every 20 minutes. The probable reason for this contrast is that grower/finisher sprinklers have become a management tool for reinforcing proper dunging habits, rather than a tool used only for evaporative cooling. Hence, they are used year-round rather than seasonally, and, in effect, at all room temperatures. The following comparison illustrates the impact of this management approach on water usage:

	Intermittent Usage	**Continuous Usage**
Activation temperature	21ºC	15ºC
Cycle frequency and length	0.5 min every 20 min.	1 min, every 30 min, greater after 25ºC
[(1)]Total daily duration of usage (min.)	4	72
Water delivery rate (l/min.)	0.9	0.9
Total water usage/pen/day (l)	3.6	65

[(1)] Derived from Western Canadian hourly temperature records

Water usage for cooling increases eighteen-fold with the continuous usage strategy. Assuming an average group size of 20 pigs/pen, these figures equate to usage rates of 0.2 and 3.3 L/pig/day for intermittent versus continuous sprinkling strategies, respectively. The latter figure is in close agreement with the average value observed in this study and reported in Table 6. Since the increase in water usage for continuous sprinkling is dramatic, this practice should be closely examined for its cost-effectiveness.

Table 6: Average Daily Cooling Water Disappearance by Stage of Production in Farrow-Finish Operations

Production Stage	No. Herds	Total Observations	Average (L/day)		Range (L/day)	
			Per Sow	Per Pig	Per Sow	Per Pig
Breeding/ Gestation	0	0	-	-	-	-
Farrowing	2	3	0.3	-	0.3 – 0.3	-
Nursery	0	0	-	-	-	-
Grower/Finisher	4	7	-	3.4	-	1.2 – 5.7

Only two units employed drip cooling in the farrowing rooms. The usage rates reported in Table 6 agree with calculated usages based on these systems running only during temperatures above 25ºC.

4.4 Washing Water Usage

Similar to water used for cooling, little information is available on water requirements for washing. Unfortunately, this study was unable to collect a significant quantity of data on washing water usage. Table 7 presents a summary of the data that were collected.

Table 7: Average Daily Washing Water Disappearance by Stage of Production in Farrow-Finish Operations

Production Stage	No. Herds	Total Observations	Average (L/day)		Range (L/day)	
			Per Sow	Per Pig	Per Sow	Per Pig
Breeding/ Gestation	1	1	0.5	-	-	-
Farrowing	2	2	1.4	-	1.0 – 1.7	-
Nursery	2	2	-	0.38	-	0.33 – 0.42
Grower/Finisher	3	3	-	0.16	-	0.14 – 0.18

The VIDO Swine Technical Group (1998) conducted a survey of Western Canada swine farms and reported the following water usages for washing:

Area	Average	Range
Farrowing	152 L/crate/wash	85-318
Nursery	12 L/pig place/wash	6-26
Finishing	80 L/pig place/wash	21-246

Extrapolated to an annual, whole-herd basis, these averages would result in usages of 1.0 L/sow/day for farrowing, 0.2 L/pig/day for nursery, and 0.66 L/pig/day for growing/finishing. With the exception of the growing/finishing value, these figures are comparable to those obtained by this study (Table 7). It should be noted, however, that the VIDO study is based on a considerably larger sample size and is thus a more likely representation of washing water usage. The large range in values reported in the VIDO study indicate that management has a large role in determining washing water requirements. Procedures such as presoaking, use of soaps, and type of washing equipment all have significant impacts and can result in two- to four-fold differences in wash water usage.

4.5 Domestic Water Usage

Domestic water usage in this study was defined as water used for human consumption, laundry, showering and hand washing, and other cleaning activities related to the barn office area. In one herd, this function also included water used for washing sows pre-farrowing. As listed in Table 2, domestic consumption accounted for approximately one percent of the total water usage. The lowest daily per head usage was recorded for two large operations, while the highest per head usage was observed on small operations. This is likely a reflection of the lower staff:animal ratio in large operations as opposed to small operations.

4.6 Waste Production Rates

Less than half of the herds monitored were able to supply reliable waste production data. The main problems encountered in collecting these data were a lack of continuous monitoring on the part of the cooperators, as well as malfunctioning pit plugs. Reliable

data were available from one small, one medium, and two large herds. These data are summarized in Table 8. Even within this small sample size, a wide range of production rates is evident. In gestation, farrowing, and nursery, the two large herds had the lowest daily per head production rates. Unfortunately, only two herds produced reliable data for waste production in the growing/finishing stage (one small and one medium sized herd).

Table 8: Average Daily Waste Production Rates by Stage of Production in Farrow-Finish Operations

Production Stage	No. Herds	Total Observations	Average (L/day)		Range (L/day)	
			Per Sow	Per Pig	Per Sow	Per Pig
Breeding/ Gestation	3	4	15.0	-	12.2 – 20.7	-
Farrowing	4	8	30.1	-	23.5 – 41.1	-
Nursery	4	7	-	3.4	-	2.3 – 4.5
Grower/Finisher	2	3	-	7.9	-	7.1 – 9.1

Table 9 compares the waste production rates obtained by this study with other rates listed by other sources. In general, there is poor agreement amongst these rates, although those quoted by the Prairie Swine Centre (2000) are closest in agreement. The rates quoted from The Netherlands are based on recent survey data of their industry (1999) and support their claim that their rates are roughly half of those produced by North American operations.

Table 9: Comparison of Daily Waste Production Values to Other Published Values

Production Stage	Source			
	MLMMI	Prairie Swine Centre[(1)]	USA[(2)]	The Netherlands [(3)]
Breeding/Gestation (L/sow/day)	15.0	15.9	3.4	9.1
Farrowing (L/sow/day)	30.1	21.8	10.2	13.9
Nursery (L/pig/day)	3.4	1.6	1.1	1.7
Grow/Finish (L/pig/day)	7.9	8.5	4.5	3.1

[(1)] Prairie Swine Centre, Pork Production Reference Guide 2000.
[(2)] Midwest Plan Service, Manure Characteristics, 2000.
[(3)] Research Institute for Pig Husbandry, Rosmalen, 1999.

From the lack of comprehensive data collected by this study, it is difficult to draw any conclusions on total herd waste production rates. Only one herd provided reliable data for waste production for all four stages of production. The calculated total waste production for this unit was 82 litres (2.9 ft^3) per sow per day.

Wastage production rates are generally listed in provincial farm practices guidelines or codes for hog producers. Accordingly, they are used in key calculations when planning and siting operations by both producers and regulatory bodies. Table 10 provides a comparison of published rates in some Canadian provinces, as well as the rates obtained by this study and those used by DGH Engineering. Unfortunately, some provinces publish rates according to type of operation rather than stage of production, so a comprehensive comparison is not possible. In general, total daily waste production rates reported by this study are higher than those listed in the Manitoba Guidelines. Guidelines from other provinces compare more favourably with the values obtained by this study, although the farrowing and nursery rates are consistently lower than the study values. Rates used by DGH Engineering for sizing of manure storages are also listed in Table 10. These rates are based on client feedback and sample monitoring, and are higher than most of the provincial guidelines figures, but are in close agreement with the values obtained by this study.

Table 10: Values for Total Daily Waste Production by Stage of Production and Comparison to Provincial and Private Guidelines

Production Stage	MLMMI	MB[1]	SK[2]	PEI[3]	DGH[4]
Gestation (L/sow/day)	15.0	7.6	15.9	15.9	22.7
Farrowing (L/sow/day)	30.1	14.2	21.8	21.8	
Nursery (L/pig/day)	3.4	1.1	1.6	2.4	3.1
Grow/Finish (L/pig/day)	7.9	5.4	8.5	9.3	8.5

[1] Farm Practices Guidelines for Hog Producers in Manitoba, 1998.
[2] Manual for: Developing a Manure and Dead Animal Management Plan, Saskatchewan Agriculture and Food, 1997.
[3] Guidelines for Manure Management for Prince Edward Island, 1999.
[4] DGH Engineering Ltd., Personal Communication, 2001.

4.7 Reducing Water Usage and Waste Production

This study has identified a number of areas where surplus water usage appears to be occurring. These are summarized as follows:

	Water Usage		
Function	**Current**	**Requirement** (L/sow/day)[1]	**Difference**
Spray cooling of grow/finish pigs	22.4	1.2	21.2
Drinking water usage by grow/finish pigs	50.1	37.4	12.7
Drinking water usage by gestating sows	12.6	5.6	7.0
Drinking water usage by farrowing sows	7.5	3.0	4.5
Drinking water usage by nursery pigs	8.5	5.5	3.0

[1] Figures are expressed on a total inventoried sow basis, extrapolated from typical animal inventories by production stage, in a farrow-to-finish operation.

Reduction of water usage to requirement levels from current levels for the functions mentioned above would represent an approximate 50 percent reduction in total water usage for a farrow-to-finish operation. Some of these savings are readily achievable, such as changing the spray cooling strategy for grow/finish pigs and 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 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 the Western Canadian industry.

The economic consequences of surplus water usage and waste production are significant. For example, the current practice of spray cooling grow/finish pigs will result in production of an additional 7,738,000 litres of effluent annually from a 1,000 sow farrow-to-finish enterprise. Direct disposal costs of this surplus effluent is approximately $17,000. This does not include the additional land required for disposal of the surplus. These costs are likely to escalate in the future.

5.0 CONCLUSION

Total water usage in five Manitoba farrow-to-finish operations averaged 89.5 L/sow/day, with a range of 71.1 L to 110.0 L, or approximately 44 percent of the average. On average, 80 percent of this total was used for watering of animals, with the next highest use being for cooling of growing/finishing pigs. Washing accounted for five to ten percent of total usage, followed by domestic use and cooling of farrowing sows.

The highest per head usage was observed in the farrowing phase, followed in descending order by gestation, grow/finish, and nursery phases. When animal inventories in each of these production stages were considered, the grow/finish stage accounted for the highest percentage of total herd usage (64 percent), followed by gestation (16 percent), nursery (11 percent), and farrowing (9 percent). The water usage figures recorded in this study for the sow herd were generally in agreement with other published values. However, values for the nursery and grow/finish herds were significantly higher than those reported in other publications.

Daily waste production rates were recorded in four herds. Similar to total water usage, the highest per head production was in the farrowing phase, followed in descending order by gestation, grow/finish, and nursery phases. Taking animal inventories into account, the grow/finish stage accounted for 66 percent of the total herd waste production, followed by gestation (15 percent), nursery (11 percent), and farrowing (8 percent). Average daily waste production rates in each phase were generally higher than those stated in published provincial guidelines, but similar to those used by industry planners.

A comparison of the water usage values to waste production values collected by this study show close agreement between drinking water usage and total waste production levels. A general assumption within the industry has been that waste production equals water consumption. This study would suggest that total water consumption is higher than total waste production, and that drinking water consumption is a close approximation of total waste production.

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 for cooling and watering of the grow/finish and gestating sow herd. Based on these observations, a cumulative reduction of 50 percent of current usage was identified as potentially achievable. It is recommended that Western Canadian research organizations 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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APPENDIX A

Instructions and Recording Forms