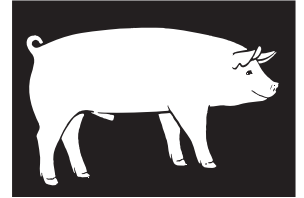




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Phosphorus Mass Balance on Swine Breeding Herd Farms¹

G. A. May² and D. W. Rozeboom³

Introduction

Government regulations require that manure be applied to cropland at agronomic rates, which on most farms establishes phosphorus (P) in manure as the limiting nutrient when determining the land base required for manure utilization in a nutrient management plan. Because P is a stable element, the total P accumulated in manure may be determined by mass balance (P coming on the farm in feed and animals – P removed from the farm in animal products = P excreted in manure). Calculating mass balance for phosphorous, requires an accurate measure of phosphorous in the diet and in the animal products removed from the farm. Additionally, swine farms must keep accurate records of feed consumption, and the number of animal removals (sales and mortality).

Whole body P content of market hogs has been studied by several research groups, but a review of literature garners only one report on the P content of sows (Mahan and Newton, 1995). Accuracy of mass balance calculations would be expected to improve if the P content of animal products removed from the farm was determined for specific animal maturities such as weanling pigs, grow-finish pigs, and sows. We conducted a study

to measure the whole body P content of cull sows at the time they are removed from the herd and to assess the impact of using an accurate measure of pig, gilt and cull sow whole body P content on the total farm P mass balance of a swine breeding herd farm.

Mineral Composition of Commercial Cull Sows

Fifteen sows were purchased from a central Michigan swine breeding herd after being culled from that herd following the standard culling protocol of that farm. Sow parity was evenly distributed among the trial animals (4, 5, and 6 sows for parity 1, 2, and 3 and greater, respectively). For each sow, blood, viscera including digesta, and carcass were processed and sampled such that each sow’s individual components and each sow’s whole body P content were analyzed.

Average P content of the fifteen cull sows was 0.563% P. This measure is lower than the Mid-West

¹ This study was made possible through the financial support of the Sustainable Agricultural Research and Education Program, Michigan State University Extension Manure AoE, and the National Pork Board. Conducted with Michigan State University’s All University Committee on Animal Use and Care exemption (Memorandum of 1-21-04) on use of animals in research as animal parts were obtained after euthanasia at a commercial butcher plant.

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Plan Service (MWPS-18, 2000) value of 0.72%, which is currently used in mass balance calculations as a measure of the P content of sows, and swine of all other phases of production. The whole body P content measured in the present study was higher than the 0.404% previously noted by Mahan and Newton (1995) for third parity sows. Sows in that study weighed less than the sows in our study (408 vs. 503 lb). Mahan and Newton (1995) determined percent P on an empty-body basis (digesta was removed from the digestive tract), instead of a whole-body basis as was used in our study (digesta remaining in the digestive tract).

Whole Farm Phosphorus Mass Balance for a Breeding Herd Farm

Mid West Plan Service -18 (2000) is currently referenced by farmers and agronomists when estimating manure nutrient accumulation on a farm. To assess the impact of using our “more accurate” measure of whole body P content on the conclusion drawn when calculating total farm P utilization, two mass balances were estimated and compared. The first used the MWPS-18 whole body content of 0.72% for all animal imports and exports and the second mass balance completed used more accurate measures of whole body P content for cull sows (present study), the replacement gilt (0.527% P; Jørgensen et al., 1986), and the weaned pig (0.376% P; Rincker et al., 2004). Both mass balances were for 2,400 sow farms, with sow average daily feed intakes during gestation and lactation being similar in both comparisons (4.5 lb and 9.2 lb respectively). Phosphorous contents of the diets (gestation 0.73% and lactation 0.76%), culling rates, number of pigs weaned and other productivity measures were also similar in both mass balances.

When the P mass balance was calculated using the MWPS-18 (2000) value of 0.72% P for all animal removals, 59,535 lb manure P_2O_5 accumulated annually from this 2,400-sow breeding herd. When P mass balance was calculated using the more accurate whole body P estimates, an accumulation of 65,096 lb manure P_2O_5 was predicted. In comparison, using the more accurate whole body estimates resulted in 5,561 lb or 9.3% more manure P. A manure nutrient management plan completed for a 2,400-sow farm based on a mass balance estimate using MWPS-18 whole body P content for all animals would require 1,073 acres averaging 150 bushel corn per acre to utilize the annual P_2O_5 accumulation. Alternatively, calculating the land base requirement using our more accurate whole body estimates for all animal transactions and the same crop productivity, would result in 1,173 acres needed for P balance on the farm.

In this comparison of mass balances done with differing P contents for sows, gilts and pigs the land base requirement differed by 100 acres. Although an accurate analysis of whole body content for various animal imports and exports from the farm is scientifically sound, the resulting difference in P mass balance has a small consequence on land base needed when developing a manure management plan for a 2,400-sow breeding herd farm. In the comparison of the two mass balance estimates the farm's total P_2O_5 differed by only 9.3%. Published data on manure application accuracy is limited. But, published and unpublished reports do infer that current manure application technology does not apply manure nutrients with greater than 9.3% accuracy (Bollinger, 2003, and Sawyer and Lundvall, 2002). Additionally, in the comparison of the whole body P content, the percent P used in the mass balance calculations would have little effect on the ultimate build up of P_2O_5 in the soils. Warneke (2004) reports that, in Michigan,

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average soils require ten pounds P_2O_5 to increase soil test results one pound P per acre. If the additional 5,561 lb P_2O_5 , estimated by using the more accurate whole body P content based on stage of production, would in reality be excreted, but a smaller land base had been determined based on mass balance calculations using the less accurate MWPS-18, whole body P content, soil P content on that smaller land base would increase by only 0.5 pounds P per acre per year.

Farms may use published daily excretion values (a.k.a. book values) to estimate manure P accumulation. Our mass balance results were also compared to the P accumulation estimate based on daily excretion values. The results of both mass balance estimations were greater than an estimate of manure P_2O_5 accumulation completed using current MWPS-18 (2000) daily P excretion rates. Annual P_2O_5 accumulation would be 43,656 lb using book values for excretion, resulting in a nutrient management plan requirement of 786 acres. Land base needs based on book values would be 387 acres less than if determined with mass balance using more accurate P whole body content estimates.

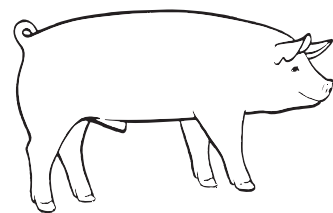
Nutrient management plans are to be written with accurate estimates of nutrient accumulation on individual farms. While MWPS-18 daily P excretion rates represent averages of many farms, mass balance is used to estimate manure P accumulation of each individual farm, accounting for between farm differences in diets and production. Plans based on mass balance using whole body P contents for each stage of production may require a larger land base, but those mass balance calculations provide a more accurate estimate of manure P accumulation for each individual farm. If swine breeding herd farms determine land base requirements using the less accurate book values, they risk P accumulating in the soil and restrictions on the use of manure as a crop nutrient. Continued over application of manure P will lead to excessively high soil P levels and loss of that land base for future manure application.

Conclusions

Calculating mass balance for P demonstrates the effect that management has on manure P accumulation through diets and production. Mass balance for P also assists with determining the location for new facilities by assuring that the site has an adequate land base for long-term environmental sustainability. Finally, determining P mass balance using whole body P content based on stage of production enhances our understanding of whole farm P balance. We now recognize more fully that the P content of swine varies with stage of production and maturity of the animal. It is more accurate to determine P accumulation based on mass balance if the calculations include P content of the animal based on stage of production.

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Water Specifications for Artificial Insemination for Swine

Tom Guthrie, MSU Extension Swine Educator, Jackson, MI

Have you ever wondered what the water specifications are in diluting semen or washing equipment in regards to artificial insemination for swine? When considering this aspect of water usage, a few factors should be considered. These factors will include pathogen removal, rinsing of equipment, dilution of extender, operating water treatment systems and wastewater cost.

There are several types of water systems available including distilled, reverse osmosis and deionized. A basic understanding of these types of water systems and what impurities are removed from water through these respective processes will aid in making an informed decision on what type of water is the most appropriate for artificial insemination.

The Distillation Process

Distillers use heat to boil water into steam. This steam is then condensed back into water and collected in a purer form. Thus, when the water boils it leaves impurities behind in the boiling chamber. The rising steam then passes into a cooling section where it is condensed back into liquid.

Reverse Osmosis and How it Works

Reverse osmosis may be referred to as ultra-filtration, involving the movement of water through a membrane. This membrane has microscopic openings that allow water molecules, but not larger compounds to pass through. Some reverse osmosis membranes may have an electrical charge that helps in rejecting some chemicals at the membrane surface.

Deionized – What is it?

Deionized water is water that has been passed through a column or membrane to remove the ions that are present.

Ultraviolet Light Water Treatment

UV light water treatment systems use low pressure mercury-vapor lamps made of hard quartz glass as the sources of the ultraviolet radiation. UV light treatment may be considered to be a very effective disinfectant when used with additional water purification systems.

Removal of Impurities – A Comparison

With this basic understanding of how each system works it is imperative to know what impurities each process removes.

The distillation process removes almost all impurities from water. Distillation units, often called distillers, are commonly used to remove nitrates, bacteria, sodium, hardness, dissolved solids, most organic compounds and heavy metals from water. Distillers remove approximately 99.5% of impurities from original water. Water impurities (0.3 to 0.5%) may exist in the storage containers after distilling. However, one thing to consider here is that even though bacteria are removed by the distillation process, they may recolonize on the cooling coils during periods of inactivity. Glass distillers should be chosen over stainless steel distillers because the stainless steel distillers may contaminate the water with aluminum.

Reverse osmosis systems reduce the levels of total dissolved solids (nitrates, sulfates, sodium). Reverse osmosis systems are NOT appropriate for treating water supplies that are contaminated by coliform bacteria. A reverse osmosis filter breeds bacteria because the water has no chlorine and is stored at room temperature.

As far as deionized water is concerned, a de-ionizing column will not remove nonionic organic substances. Thus deionized water will still contain potential contaminants that can be detrimental to semen viability.

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When considering a UV light treatment system, performance depends on clarity of water, contact time and the dose of light. Therefore, this system will be ineffective in turbid or murky water or quickly passing water because it does not give enough time to kill all microorganisms. This system works well as a disinfectant. However, this system does not remove toxic chemicals, heavy metals or other contaminants.

Disadvantages of Distillers and Reverse Osmosis Units

Distillers have small capacities and use considerable energy to process water. Typical operational cost of distillers may range from \$0.35 to \$0.50/gallon. In comparison, reverse osmosis units use lots of water, recovering only 5 to 15% of the water entering the system with the remainder being discharged as waste water. For example: a reverse osmosis unit delivering 5 gallons of treated water may discharge 40 to 90 gallons of waste water. Other factors to consider when evaluating water systems are the initial cost of the system, installation costs, maintenance costs as well as the operating costs that were previously discussed.

In conclusion, distilled water and reverse osmosis water have some similarities but do differ, especially when it comes to pathogen removal. Distilled water appears to be the most effective type of water to use when considering pathogen removal. However, conducting a water test may be beneficial to determine what type of impurities exists in your water supply.

Other Helpful Hints

One drop of contaminated water in an insemination rod can create a problem. If you are using a re-usable artificial insemination rod it must be rinsed (preferably with distilled water) immediately before use.

Using distilled water to make the final rinse on equipment and for dilution of extenders should reduce problems that can occur with other water sources,

since the distilling process will remove virtually the potential contaminants as well as any potential pathogens that could reduce semen viability.

Information for this article is referenced to the following resources.

<http://www.ext.nodak.edu/extpubs/h2oqual/watsys/ae1032w.htm>

<http://www.water-filter-basics.com>



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Importance of Boar Exposure in Heat Detection

**Ronald O. Bates, State Swine Specialist
Michigan State University**

A major step in having an efficient sow herd is determining heat or estrus in sows after weaning. Sows typically return to estrus within 4-10 days after weaning and will stand in estrus for 2-4 days depending on their age, time of year and their own predisposition to exhibit behavioral estrus.

Determining which sows are in heat is an important task and one that takes experience, skill and stockmanship. When sows are in pens and provided physical boar exposure, the boar will do much of the work and will try and mount sows that are in standing estrus or heat. However, when checking heat in sows housed in individual stalls, more skill and experience is necessary.

With sows in individual stalls, the boar still has an important role. Past research has shown that fence-line contact, including moving boars past the front of the stalls, will improve the expression of standing heat in sows. Once a sow achieves standing heat, she will show the typical standing heat behavior for approximately 15 minutes. After 15-20 minutes she will become refractory. Once a sow becomes refractory she will show less interest in the boar, may not show the typical signs of heat and often will not allow a boar to mount.

In an effort to determine how different heat checking methods may influence this refractory state in sows, a recent study^a compared three (3) heat checking protocols. Heat detection was

determined with exposure to a mature boar at approximately 7 am every day. This was followed by subsequent heat checking with a boar at 15 minutes and 30 minutes after first exposure as well at 1, 2, 4 and 8 hours after the first exposure to a boar. The three housing protocols evaluated were; 1) Sows were housed either in individual stalls, 2) or grouped into pens away from boars and, 3) grouped in pens adjacent to boar stalls.

Sows that were housed in stalls or in pens and housed away from boars took less time to achieve estrus after weaning (4.7 days) compared to sows housed in pens adjacent to boars (5.1 days). In addition, a greater percentage of sows housed in stalls and in pens away from boars achieved estrus within 7 days (96% and 98%, respectively) compared to sows housed in pens adjacent to boars (80%).

When evaluating the repeatability to show behavioral signs of heat within the first 2 hours after showing the initial standing heat, only 62-82% of sows initially determined in behavioral estrus again showed standing heat in the presence of a boar. Percentage of sows showing behavioral

^aKnox, R.V., S.M. Breen, K.L. Willenburg, S. Roth, G.M. Miller, K. Ruggiero and S.L. Rodriguez-Zas. 2004. Effect of housing system and boar exposure on estrus expression in weaned sows. *J. Anim. Sci.* 81:3088-3093.

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estrus, was lowest when checked at 15 and 30 minutes after initial detection of standing heat and then increased over the next 1.5 to 3 hours. At 4-8 hours after initial detection of standing heat, there were treatment differences. Sows housed in pens adjacent to boars had a lower frequency of subsequent heat detection (73%) compared to sows housed away from boars in pens or stalls (98% and 85%, respectively).

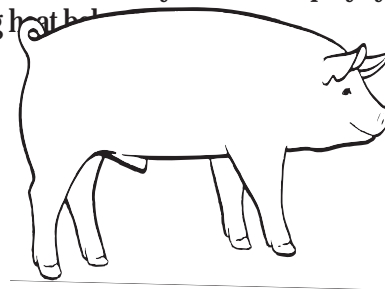
This study demonstrates the power of boar exposure in detecting sows in heat as well as that there can be too much of a good thing. Boar exposure must be an important part of daily heat detection. Exposure to a mature boar is critical when detecting heat in weaned sows. In addition this study also shows that after heat detection is completed, the mature boar must be housed away from females. Continuous exposure to mature boars will cause sows to have a less demonstrative behavioral estrous response. This can cause a delay in finding a sow in heat and possibly mating the sow at a less than optimum time for maximum conception rate.

For farms that house weaned sows and non-mated gilts near boars, the boars should be moved away from these non-pregnant females to improve the ability to detect these females in heat. In addition, within the first 15 minutes after detection in estrus, boars need to be moved away so as not to extend the refractory period.

Farms that house boars away from weaned sows and non-mated gilts must be cautious about the duration of boar exposure. When moving a boar in front of weaned sows housed in individual stalls, persons need to be conscientious of the duration of exposure that individual sows may get. For example, if boars are being moved slowly in front of sows housed in individual stalls, sows that will soon have the boar in front of them may already be conscious of his presence and initiate their standing heat response. If

too much time elapses between the time a sow knows that a boar is present and when a person checks her for heat, she may become refractory and determined to be “iffy” or not quite in heat. This could cause her not to be mated until later in her heat period and this may be less than optimum for conception.

Periodically, farms should evaluate their heat detection protocols. Sow farms should house heat check boars away from weaned sows and non-pregnant gilts. When checking heat, boar exposure should not be rushed and females should be provided sufficient boar exposure (up to 10 minutes), but if boar exposure is allowed to continue for more than 15 minutes, females will become refractory and not display typical standing heat behavior.



Spartans Honored in the NATIONAL HOG FARMER'S 50TH Anniversary Issue

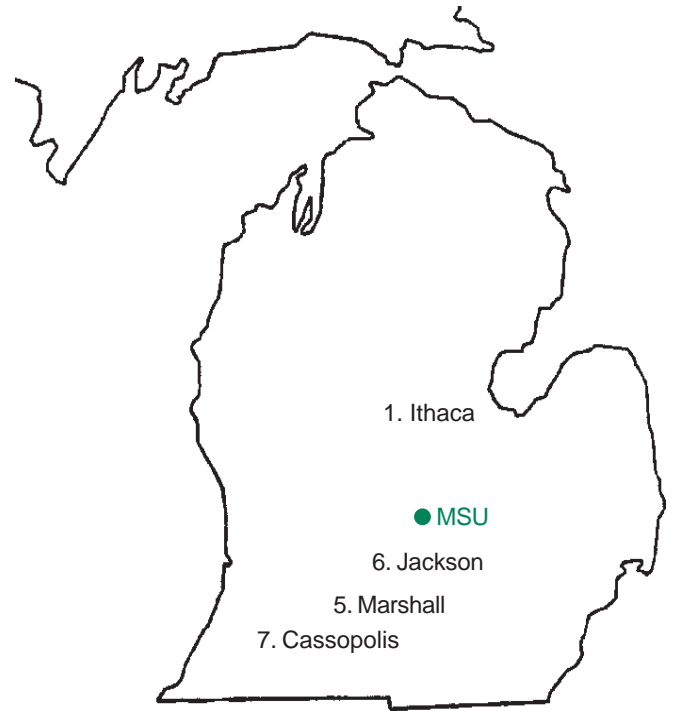
The *National Hog Farmer* recognized former MSU State Swine Specialist Ed Miller and Swine Nutrition Scientist Elwyn Miller in its recent 50th Anniversary Issue.

Mr. Ed Miller served at MSU from 1955 to 1974 and filled several roles. Mr. Miller taught the undergraduate Swine Management course and served as Faculty Coordinator for the MSU Swine Teaching and Research Center. Mr. Miller will probably be best remembered for his many innovative Extension programs. He developed the Annual Swine Day, developed Swine Management

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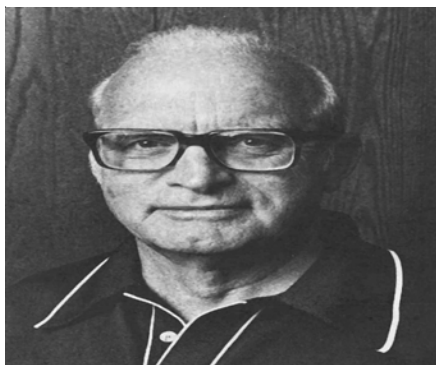
All comments and suggestions should be directed to:

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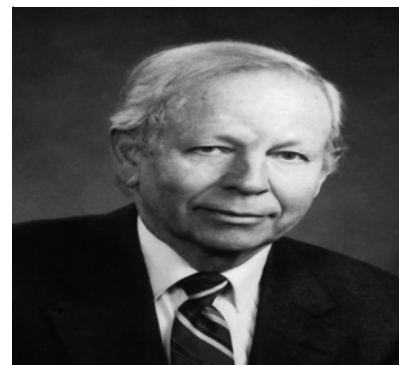


Short Courses for producers and helped develop the Swine Testing program and grading of market hogs. In addition he helped form the Michigan Pork Council, which focused on producers improving the competitiveness of their farm businesses.

Dr. Elwyn Miller served on the faculty at MSU from 1956 to 1994. Dr. Miller's research focused on the nutritional needs of baby pigs. His vast research on vitamin and mineral requirements of the developing pig laid the groundwork for much of what is known today about pig vitamin and mineral nutrition. He led the way for the use of iron dextran injection for baby pigs and developed methodology to measure bone strength and quantify its relation to dietary mineral consumption. This methodology became the accepted standard by scientists around the world. In 1984 he received the American Society of Animal Science's Morrison Award, the society's highest award for nutrition research.



Dr. Ed Miller



Dr. Elwyn Miller