

2002 Annual Research Report

PRAIRIE SWINE CENTRE INC.

Our Mission

"To be a Centre of Excellence in Research, Technology Transfer and Education, all directed at efficient, sustainable pork production in Canada."

Table of Contents

Glossary iii

Chairman's Report: *Innovation in the face of market challenges* 5

President's Report: *A decade of service to industry, to producers* 6

Report from the Manager – Operations: *Solid genetics and new facilities mark 2002* 8

Report from the Manager – Information Services: *Informing producers and the public online — and in person* 9

Pork Industry Interpretive Centre Becomes a Reality 10

Research Goals: *New updated guides for PSC* 11

Engineering

- Feasibility Study for Concrete Swine Buildings and Manure Storage Facilities in Western Canada. 12
- Effect of Extender, Cooling Method and Incubation Time on Storage of Extended Boar Semen at 5°C. 14
- Draeger microPac Performance for Hydrogen Sulphide Monitoring in Commercial Swine Operation. 16
- Hydrogen Sulphide Concentration While Pulling Pit Plugs and Power-Washing Rooms. 17

Behaviour

- Effects of Large Group Size on Productivity of Grower-Finisher Pigs. 19
- Growth Rate and Age at First Estrus: Impact on Managing the Gilt Pool. 20

Nutrition

Feed Processing and Nutritional Quality Among Wheat Classes Fed to Weaned Pigs. 22

Reducing Water Waste From Nipple Drinkers by Growing-Finishing Pigs. 23

Water Usage by Grower-Finisher Pigs Using Dry and Wet/Dry Feeders. 24

The Effect of Dietary Energy Concentration and Lysine:
Energy Ratio on the Growth Performance of Weaned Pigs. 25

The Performance of Growing-Finishing Pigs Fed Diets With Reduced Crude Protein. 26

The Methionine Requirement of Pigs from 25 to 50kg. 28

Environment

Comparison of Urination Frequency of Grower-Finisher Pigs to Ammonia Emission. 30

The Net Energy System and Diet Manipulation: An Overview. 31

Can We Alter Water Utilization in Growing Pigs by Diet Manipulation? 33

Moisture Production of Grower-Finisher Pigs: Field Measurements Compared with Theoretical Values. 35

Effect of Dietary Crude Protein Content and Phase Feeding on Performance and
Urinary Nitrogen Excretion of Grower Pigs. 36

A Low Protein Diet and Oil Sprinkling to Reduce Ammonia Emissions from Pig Barns. 37

Airborne Dust, Endotoxin and DNA Downwind from Swine Barns: An Update. 38

Impact of Combining a Low Protein Diet and Oil Sprinkling on Odour and Dust Emissions of Swine Barns. 40

Publications 41

Glossary

ADF – a fibre fraction used to identify characteristics of feed stuff.

ADFI – average daily feed intake.

ADG – average daily gain.

ad libitum – full access to feed or unrestricted feeding.

ammonia – NH_3 a nitrogen compound found in household cleaners, commercial fertilizers and manure. Evaporates easily at relatively low temperatures.

ammonium – NH_4, a nitrogen compound found in commercial fertilizers and manure.

ANOVA – analysis of variance. A statistical tool used to compare independent variables.

anthropogenic – caused or produced by human activity.

ß-glucanase – beta glucanase; an enzyme that breaks down beta glucans, a type of carbohydrate.

BW – Body weight.

caecum – the cul-de-sac where the large intestine begins.

cannulated – to insert a small flexible tube into the small intestine to measure ingredient absorption.

chromic oxide – Cr_2O_3, a stable compound that doesn't dissolve in water and is largely unaffected by digestive acids.

CP – crude protein.

CV – Coefficient of variation. A statistical tool for measuring dispersion.

DE – dietary energy.

DM – dry matter.

digesta – digested feed.

endotoxin – poison produced by certain bacteria and released upon destruction of bacteria cell.

epididimectomized boar – surigal alteration of penal attachment to prevent the boar from breeding.

glucosinolates – naturally produced antinutritional chemicals that can hamper growth rate and cause thyroid problems in animals.

Gram test – bacteria are classified as Gram negative or positive using stains to determine differences in their cell walls.

H_2S – hydrogen sulfide. A colourless, poisonous gas that produces a "rotten egg" odour. In pig barns it is produced by the breakdown of manure and is extremely hazardous if not managed properly.

hedonic tone – subjective measure to the pleasantness or unpleasantness of odour.

ileal – pertaining to the latter part of the small intestine, or ileum. Nutrients from feed are absorbed in this area.

ileum – the lowest portion of the small intestine.

K – potassium.

kcal – kilocalorie, or one thousand calories. A calorie is the amount of energy required to raise one gram of water one degree.

lysine – an amino acid essential for growth. Cereal grains are generally poor in lysine.

nitrate – NO_3, a nitrogen compound found in manure.

N – nitrogen (N_2), a major component of the atmosphere and an essential plant nutrient.

NDF – neutral detergent fibre. One fraction of total fibre found in a feedstuff.

operant conditioning – a process of changing behavior by rewarding or punishing a subject each time an action is performed until the the action is associated with pleasure or distress.

P – phosphorus.

plasma urea – urea contained in blood plasma. Urea is the principal end product of nitrogen metabolism in mammals.

progressive sperm motility – percentage of sperm moving in a forward fashion.

proximate analysis – a testing protocol used to determine the makeup of a foodstuff, e.g. fats, proteins, carbohydrates.

psychrometer – an instrument used for measuring water vapor content or relative humidity using a pair of moist and dry thermometers.

regression analysis – a standard statistical tool for comparing the relative behaviour of two or more variables.

SEM – standard error of the mean. A way of stating how accurate data are.

sonicating – mixing or homogenizing a liquid using sound waves.

spectrophotometry – using different wavelengths of light to analyze materials.

total sperm motility – percentage of sperm moving.

viability (sperm) – percentage of living sperm.

xylanase – an enzyme which breaks down xylans, a type of carbohydrate.

Chairman's Report

Innovation in the face of market challenges.

The Prairie Swine Centre, like all of us in the industry, faced challenges in 2002 that almost seemed to set new standards. The drastic low in hog prices in the early fall was exacerbated by increased price of feeds and limited availability of grains. (The only good thing about the very low prices for hogs on our farm in east central Alberta was that it helped us forget for a while that we had no crop!)

The Centre again demonstrated it's important role in increasing resilience of hog producers.

Prairie Swine Centre management was once again forced to address the effect of significantly reduced revenues on various programs. At the same time, an opportunity arose for the Centre's professionals to help producers develop use of alternative feedstuffs. The Centre again demonstrated the important role its people and programs can play in increasing the resilience of western Canada's hog producers.

The Centre's mandate includes helping all of us in this industry drive costs out of our production systems and meet the increasing environmental, nuisance and welfare concerns we are all facing.

The Elstow Research Farm, with its 600-sow base, is up and running. It very effectively complements the original 300 sow Floral facility in providing a strong base from which to conduct world class research and technology transfer programs. That, quite simply, is what the industry has come to expect.

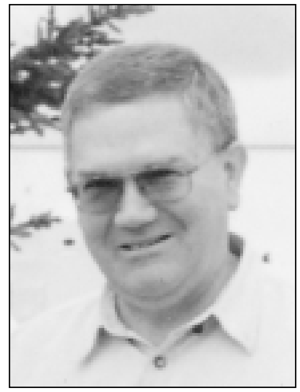
With the whole system in place, it was time to have a look at the mandate of Prairie Swine Centre again. Led by John Patience, the management team and Board of Directors went through a very comprehensive strategic planning process. This was successful only with valued contributions by producers, the industry and university personnel.

Clear direction was defined and the Centre can move forward confident that its course of action is consistent with the requirements of both the research community and the industry in western Canada.

The Pork Industry Interpretative Centre at Elstow is nearing reality. It is important to acknowledge the work in getting the construction underway. Lee Whittington led the management team and the advisory committee in not only fundraising, but in assuring the facility will deliver the appropriate information. Tremendous broad based support by various industry players was essential to provide the funding. Particularly remarkable were the contributions by producers either through their organizations or independently.

This report is presented on behalf of a very interested Board of Directors of Prairie Swine Centre, who represent a unique group of stakeholders. The producer component of each Prairie province is represented, along with Saskatchewan Agriculture and Food, the University of Saskatchewan and the Prairie Swine Centre itself through the president. I had the pleasure of working with John Patience, meeting the Board of Governors of the University of Saskatchewan, and discussing the appointments to and role of the Board of Directors of the Centre. All of us, as Directors, are honored to accept our appointments because we believe strongly in the work being done.

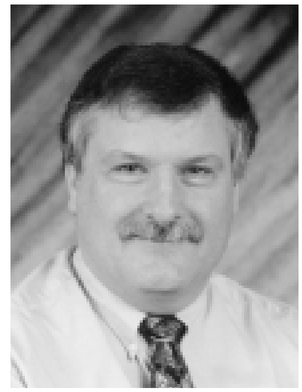
The University of Saskatchewan supports the Prairie mandate of the Prairie Swine Centre and recognizes its importance to all of us who count on the hog industry for our livelihood.



Bryan Perkins
Chairman of the Board,
Prairie Swine Centre
Owner/Operator: Perkins Farms Inc.

President's Report

A decade of service to industry, to producers.



Dr. John Patience Ph.D
President and C.E.O.

The past year was a significant one for the Prairie Swine Centre, as it represented the end of our first decade operating as a non-profit corporation. The new operating structure has served us well. We saw growth in our personnel from seven to almost 50 full and part-time staff and students, in our revenues from $378,000 to more than $5 million and most critically, in our reputation as an applied pork production research organization.

Support for our programs has come from six Canadian provinces and seven nations on three continents

It has been an exciting decade, marked by an extraordinary unity of purpose demonstrated by the pork producers in Manitoba, Alberta and Saskatchewan – through their provincial Boards, the Province of Saskatchewan – through the Agriculture Development Fund, and the University of Saskatchewan to support a research organization such as ours. The absence of any one of these key contributors would have dramatically altered the course of the Centre's history, and inevitably resulted in less research and less benefit to the other stakeholders. There is strength in numbers, and there is value in co-operative and collaborative effort, and the Prairie Swine Centre demonstrates this very well. Over the past decade, annual research revenues have grown from $860 thousand to $2.5 million. A total of 71 public and private agencies have supported our public research program, and these sponsors represent six Canadian provinces, three continents and seven different nations.

While the past has seen the Prairie Swine Centre, as well as the pork industry, grow and mature, in order to maintain success, it is the future upon which we must focus. Last year, we initiated the strategic planning process and this year it was completed. A combination of personal interviews and group meetings with representatives of all sectors of the industry, plus an internal analysis using the combined expertise of all of our staff, provided the essential direction needed to define the Prairie Swine Centre of the future. We defined our new vision "to be an internationally recognized source of original, practical information for the pork industry" and our mission "to be a centre of excellence in research, graduate education and technology transfer, all directed at efficient, sustainable pork production." We further defined our core competencies as expertise in nutrition, engineering and ethology, our extensive, well-run swine research facilities, a high profile technology transfer program, a highly successful contract research program and perhaps most importantly, our relationship with the western Canadian pork industry. We defined seven strategic goals, which are reproduced elsewhere in this annual report, and also re-defined our six research objectives. On the basis of input from the industry, our research will continue to focus on economic efficiency, to support continued competitiveness in the global marketplace and on sustainability, to provide scientific data that can be used by our industry to make informed decisions on such important issues as animal welfare and the environment.

Economic efficiency remains our research focus

Perhaps the most innovative component of our strategic plan is an extensive list of measurable targets, to help us track our progress in moving forward based on the seven strategic objectives. Our research scientists have very specific productivity targets, not based on the number of experiments completed or the number of publications in scientific journals (although this is also a measurable in our plan), but rather on the development of what we called "strong concluding statements of research results." These statements must provide clear and valuable information to the industry, based on our research objectives and derived from successful completion of an experiment or series of experiments. If we apply the management mantra that "you cannot manage what you do not measure," with our list of 37 quantitative measurable targets, we should be well-positioned to maintain our Centre's focus and move forward in a manner that is consistent with the needs of our stakeholders.

As a result of the strategic planning process, we have decided to exit the management training program, and will only become involved in training at the farm level when it represents a vehicle for technology transfer. Therefore, we will maintain a role in H_2S Awareness training, although the actual delivery will be provided by third-party contractors. We regretted our exit from the Management Training Program, but it clearly was not a part of our new strategic objectives and did not fit well with our core competencies. I would like to thank Mary Peterson, our Training Coordinator for the enthusiasm and commitment she had for our Management Training Program.

No organization achieves success without a committed staff. We are very fortunate to have excellent people from research scientists and managers through to production and research support. So much effort is involved in the background to bring a research program and a technology transfer program to reality. We must never forget the team-work required to accomplish this efficiently and effectively.

Research statements will provide clear and valuable information to the industry.

I would also like to thank our Board of Directors, very ably Chaired by Bryan Perkins of Wainright, Alberta. They are such a key part of the Centre's planning and vision and provide outstanding support, input and encouragement to those of us working at the Centre. They receive no compensation for their efforts or their time, but their enthusiasm is priceless.

I save my final words of thanks for the three pork Boards - Sask Pork, Manitoba Pork Council and Alberta Pork - as well as the Agriculture Development Fund and the University of Saskatchewan for their continued support of this dream – and this reality. At a time when so many forces seem to drive agriculture apart, it is exciting to be a part of this co-operative and collaborative effort at work in the pork industry.

Board of Directors (from left to right): Mac Sheppard, Dr. Ernie Barber, Dr. Bryan Harvey, Harvey Wagner, Marilyn Jonas, Marten Wright, Dr. John Patience, Ron Rempel, Bryan Perkins. Missing: Roger Charbonneau

Report from the Manager – Operations

Solid genetics and new facilities mark 2002.

Production for this fiscal year, 2001/2002, faltered slightly from the previous year in relation to numbers born alive and subsequently number weaned per sow per year. We are currently in discussions with Pig Improvement Canada to repopulate the Floral and Elstow facilities with a genetic line that will result in an F1 female known for large litters of pigs born alive along with great mothering ability resulting in larger numbers weaned throughout her productive life. This female is also well suited to intensive housing situations.

The use of the Line-65 boar as our terminal sire continues to improve market performance over the last year. Over the last three fiscal years, index has risen from an average of 107.73 to 109.50. We have also been able to increase average dress weight from 85.98 to 90.44 kg. as days to market decrease and available finishing space increases. It must be remembered that all production figures include total animals on farm, and will include animals used in research trials. Performance in most research trials improves production targets, but some of the research protocols are developed to change normal management practices or have an affect on nutrition or behaviour that impairs the pigs' performance for growth and development. If this is the case, researchers are required to contribute financially to the production side of the operation to compensate for any losses incurred because of the trial.

In 2002 Prairie Swine Centre Inc. used 8,190 animals in 33 different experiments in the research program assigned to the University of Saskatchewan Assurance of Animal Care Forms. The addition of the PSC Elstow Research Farm has greatly increased our capacity for research. Before the Elstow facility could be fully used in 2000, a total of 4,433 animals were used in 26 experiments. With PSC Elstow in full operation in 2001, a total of 12,745 animals were used in 46 experiments, slightly more than this calendar year.

The Board of Directors of Prairie Swine Centre Inc. gave approval for the construction of three new nursery rooms in June of 2002. Prior to approval, staff and management determined relevant production and research issues influencing the construction of three new nursery rooms and renovating the existing three rooms built in 1995. All six nurseries would accommodate present and future production, on a weekly basis. All scientists agreed that the current group size of 96 or 120 pigs per room for animals on trial was sufficient. Extra space per room was calculated to ensure animals not on trial could be housed with their nursery group to ensure all-in-all-out management. An automatic feed system would be installed to feed production diets minimizing labour when rooms were not on trial.

Extra costs associated with research requirements for all projects at Prairie Swine Centre Inc. need to be considered as a substantial part of a construction project. In the case of the nursery expansion, "extras" for design, construction, and materials and equipment are as follows:

Extra costs are required to split pens in all rooms allowing more experimental replicates. Costs associated with penning material, drinker drops and lines, and feeder costs substantially increase the cost of construction per room.

Brian Andries B.Sc.
Manager, Operations

The addition of eight feed bins, down spouts, augers, motors, and electrical hook-ups needed to store experimental diets along with associated costs of bin pads, and extra square footage in the hallway to access feed, was also needed.

The ability to use six nursery rooms of similar construction will greatly enhance this facility's flexibility to set up nursery research trials. The Floral facility currently houses pigs in the nursery for a five-week period before moving to grow-finish. This will allow a one-week clean up period between batches, a luxury we did not have previous to the new construction. As 35% of all animals used in research trials last year were nursery pigs, I would predict that the new nurseries will result in a substantial increase of nursery experiments at the Floral facility.

Table 1. Production parameters for the 99/00, 00/01, 01/02 fiscal years

	99/00	*00/01*	*01/02*
Sows farrowed, #	781	722	750
Farrowing rate, %	91.2	87.3	88.1
Pigs born alive/litter	11.2	11.4	11.0
Pre-weaning mortality	11.5	12.7	10.9
Litters weaned	797	728	754
Pigs weaned	8033	7311	7415
Weaned/female inventory	24.5	24.8	23.9

Report from the Manager – Information Services

Informing producers and the public online — and in person.

This year special thanks goes out to Ken Engele, who made it possible to continue the many projects and answer requests for information, while I was completing the final phases of the Pork Industry Interpretive Centre.

Primarily the Centre's funding, and our reason for existing, comes from the pork producers in western Canada. With their help, and input from many suppliers and other researchers, we redeveloped the focus for all our programs for the coming five years. The original concepts for our research and technology transfer programs were again endorsed by the industry, as they noted that as their business evolves, so must our programs.

This evolution of science and technology transfer programs will become apparent over the next few months as our new plans are put in place. Many features such as this *Annual Research Report* and the quarterly *Centred on Swine* will stay in their current format. But these vehicles alone are insufficient for bringing you the information as quickly as it is developed. The enhancement of the Web site will be at the root of the improvements in communication. Already there is a growing library of summaries created from research completed at PSC and other institutions on our site. This resource will continue to grow as this is the most efficient and accessible place to store information.

Who uses our Web site? Primarily Canadian pork producers and their agencies, although other researchers and the supplier industry also find the information a valuable tool. The graph below shows the current usage trends based on registered users of the searchable database.

Focus on the Future continues to grow each year. The interest in group housing at last year's conference in Winnipeg was intense. During this same period we had numerous tours by producer groups through the Elstow facilities to look at and discuss group housing with our staff. The development of the Interpretive Centre viewing windows will make our operations even more accessible.

Tours have always been a large part of learning. Ken led a small group to the World Pork Expo, with side trips to production facilities and feed manufacturers in the Des Moines area.

The Pork Industry Interpretive Centre and Sask Pork Viewing Gallery will open in March 2003. First conceived in the summer of 1998, this initiative is our response to the growing desire world-wide for more transparency and accountability in our food system. This educational facility will allow groups to visit a working pig barn. Through the use of interactive displays, signage and a tour guide, visitors will see first hand how pigs are cared for, and the science behind stewardship of the land. It is our hope that visitors will begin to appreciate the pig and its vital role in rural Canada.

PSC Website Users

Type of visitor*	October 2001	October 2002
University/education	22%	19%
Producer	32%	26%
Service/supplier	18%	21%
Government	9%	12%
Non-government agency	7%	5%
Consumer	2%	3%
Other	10%	14%

Lee Whittington B.Sc., MBA
Manager, Information Services

So who do we serve? We serve the needs of pork producers for timely, accurate and innovative information. This now includes, providing greater access to the neighbours and consumers through the educational opportunities of the Pork Industry Interpretive Centre.

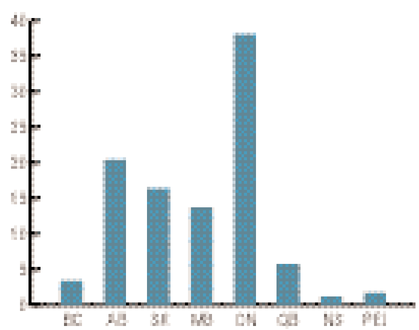


Figure 1: Percent of Canadian Users

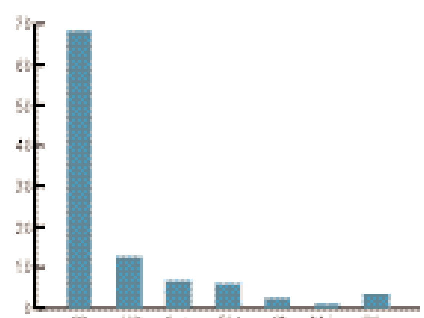


Figure 2: Percent of total online Database Users

Pork Industry Interpretive Centre Becomes a Reality

When Prairie Swine Centre sought industry input for a proposed new research facility in 1998 the concept of allowing the public to view inside the barn came to the fore as a significant and unique role the facility could provide in addition to its research mandate. Fast forward to 2003, The Pork Industry Interpretive Centre and Sask Pork Viewing Gallery is nearly complete. Many people have contributed to getting the facility to this point including; 90 donors who have contributed over $900,000 toward the construction, display development and operation of the facility; and a Development Committee with pork producer and association members from Saskatchewan, Alberta, Manitoba and Ontario. The end product has an inviting and fun look as it delivers the experience the pigs provide combined with a series of messages about how pork is produced.

Objectives of the Project

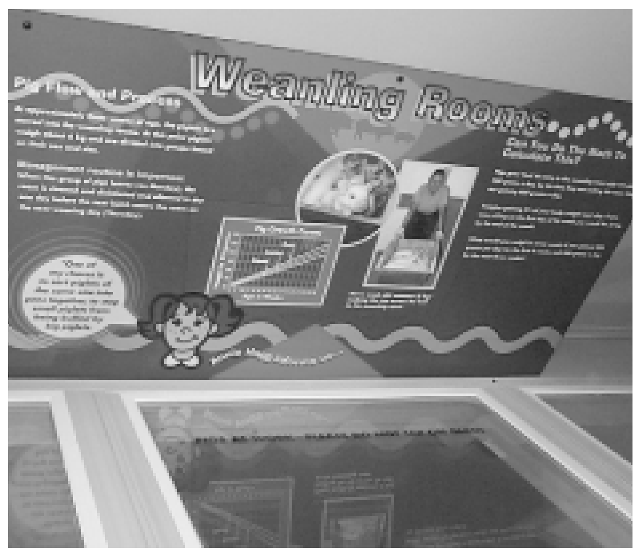
The Interpretive Centre and associated Sask Pork Viewing Gallery have four operational objectives:

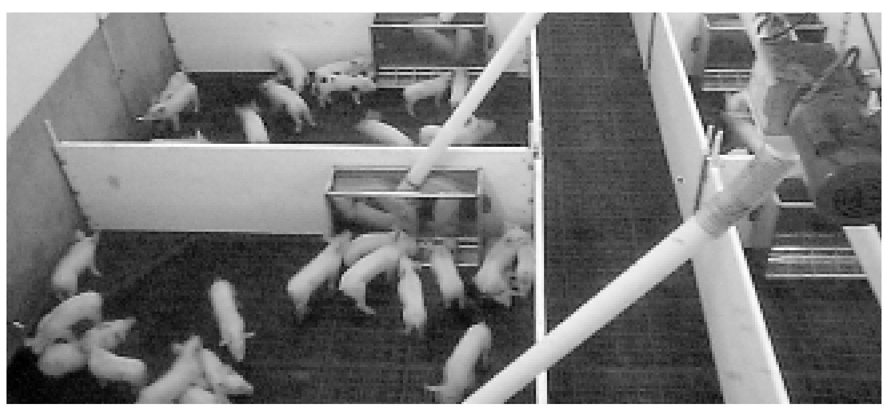
1. Allow groups and individuals to see a typical commercial pork-producing farm.
2. To provide a resource to the prairie pork industry to focus communication resources.
3. To permit an ‘open door’ through which to view the industry.
4. To allow pork producers greater access to see research taking place at the Centre.

These objectives will be met using a combination of interpretive signage, hands-on displays and of course viewing the behaviours and activities of the pigs themselves. These will be complemented with a knowledgeable tour guide to assist groups to better understand what they are seeing and how this relates to the larger industry and its contribution to the food chain.

The Interpretive Centre uses the science and social studies of everyday life in a pig barn to capture the visitor’s attention and separate fact from myth. The experience of watching pigs is expected to be the highlight for the visitors to the Centre. School groups (primarily grades 6-10), young adults seeking careers in agriculture, municipal councils, regulatory authorities, prospective neighbours to a planned barn and investors are among the main groups the Centre hopes to attract.

The facility will be open this fall and offers a great experience for those outside our industry to get good information and a positive experience about the production of pork.





The Centre's Goals

Goal #1 To meet the technology needs of the pork industry by developing original, practical information that ensures maximum profitability combined with acceptability of the industry and its products.

Goal #2 To serve the pork industry by maintaining a timely, effective and focused technology transfer program.

Goal #3 To ensure the relevance of the Prairie Swine Centre to the pork industry and to meet the needs of outreach programs by operating efficient, highly productive and profitable pig herds at its research sites while meeting or exceeding the standards of the Canadian Council of Animal Care.

Goal #4 To enhance the Centre's effectiveness and sustainability, and to encourage increased research on pigs, by developing collaborations, co-operative action and strategic alliances in research, education, and technology transfer.

Goal #5 To meet the long-term needs of our stakeholders through effective management of our human, financial, intellectual and physical resources.

Goal #6 To achieve financial and operational sustainability through diversity of funding, efficiency of operations and accountability to stakeholders.

Goal #7 To contribute to the development of highly qualified personnel through active and full participation in the graduate program at the University of Saskatchewan.

Feasibility Study for Concrete Swine Buildings and Manure Storage Facilities in Western Canada

Stéphane Lemay, Claude Laguë [1], and Liliane Chénard

Summary

A feasibility study has been completed to evaluate the potential of concrete swine buildings and manure storage facilities in the Prairie region. Three building concepts combined with four manure storage options have been studied. A building with concrete walls and wood truss roof would increase concrete usage by 25% compared to a conventional wood frame building. The various combinations of building and manure storage concepts were evaluated for their effect on annualized building costs.

A pig barn with concrete walls and manure tanks promises the best longevity and reduced costs.

The result of this evaluation either decreased annualized building cost by 16% or increased it by up to 34%. A swine facility design with concrete walls and concrete manure tanks is the most promising option for enhancing the life cycle and reducing the annualized cost of production facilities. Supplemental information should be gathered about the design and cost of swine buildings with concrete walls considering construction techniques and local availability and pricing of concrete in the Prairies.

Introduction

Swine production is expanding in many areas of Canada, especially in the Prairies. Independent and corporate producers are interested in investing and developing this industry so their needs in terms of production systems and facilities can vary. Most of the building construction that occurs in the Prairies presently is done with traditional wood framing structures and earthen manure storage (EMS) facilities. Other types of livestock facility design with concrete wall panels have been constructed, mainly in Ontario (Figure 1), over the last 20 years. Concrete walls have been chosen as a way to increase building life cycle and also to improve rodent control.

Similar alternatives for buildings and manure storage facilities have not been extensively explored yet for the Prairie conditions. Limited information has been gathered. As a result, there is a knowledge gap that prevents swine producers from considering different building and manure storage alternatives within their decision-making process.

Meanwhile, the Cement Association of Canada (CAC) is interested in expanding the market of its member companies and wanted to explore the potential of new building and manure storage facility designs for the swine industry. In 2001, CAC mandated PSC to complete a preliminary feasibility study on alternative buildings and manure storage facilities for Prairie swine operations.

Depending on the combinations of materials used, building costs decrease by 16% or increase by 34%

Study Procedures

Three building concepts and four manure storage options have been evaluated. The reference building and manure storage concepts (building concept 1 and manure storage concept A) were based on the Prairie Swine Centre Elstow Research Farm, a 600-sow farrow-to-finish operation of standard wood construct with an EMS. The three building concepts included:

1. a conventional design incorporating wood frame walls and wood truss roof;
2. a building with concrete walls and wood truss roof; and
3. a building with concrete walls and an insulated concrete slab for roofing.

The studied manure storage concepts were:
A) a regular EMS;

B) an EMS with a synthetic liner;

C) a concrete manure tank; and

D) a deep pit concrete storage underneath the barn.

Results and Discussion

Building concepts 2 and 3 would respectively increase concrete usage by 25 and 107% compared to a conventional wood frame

Figure 1: *Fan arrangement and manure pit design along the sidewall of the concrete barn built by FRED GROENESTEGE CONSTRUCTION LIMITED (Sebringville, ON).*

[1] Dean, College of Engineering, University of Saskatchewan

building (Table 1). The concrete volume required by manure storage concepts C and D would exceed that required by concept A by 60 and 183%. If building concept 3 is combined with manure storage concept D, the total concrete usage would be practically three times that used with a typical farm construction (concepts 1 and A).

More information needs to be gathered on design safety, construction techniques and local availability of concrete.

The various combinations of building and manure storage concepts either decreased the annualized building cost by 16% or increased it by up to 34%. Considering the concrete usage, the cost analysis and the pros and cons of each combination, building concept 2 combined with manure storage concept C is considered to be the most feasible options that would provide Prairie swine producers with more durable facilities at a lower cost.

A deep pit barn design (concept D) could offer some benefits and would greatly increase the concrete demand. However, considering potential safety risks associated with possible H_2S accumulation in the barn and corrosion problems, as reported in other jurisdictions. More research needs to be completed before heavily promoting this barn concept.

Implications

A swine facility with concrete walls and concrete manure tanks constitutes the most promising option for enhancing the life cycle and decreasing the annualized cost of production facilities. Supplemental information should be gathered about the design and cost of swine buildings with concrete walls considering construction techniques and local availability of concrete in the Prairies and life cycle maintenance requirements.

Acknowledgements

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by the Cement Association of Canada. The authors also thank Ms. Carolyn Ferh and Mr. Michel Payeur for their technical assistance during the study, Dr. Ernie Barber from the College of Agriculture at the University of Saskatchewan for his valuable input and Mr. Dennis Hodgkinson, P.Eng. and Kent Tolton E.I.T. from DGH Engineering Ltd who completed the cost analysis of the various building and manure storage concepts.

Table 1. Volume of concrete used for different building and manure storage concept combinations

Building concept	Total volume of concrete (m^3/site) [Increase compared to concepts 1 and A; %]			
	Manure storage concept			
	A	B	C	D
1	1,757 [0]	1,757 [0]	2,804 [60]	4,975 [183]
2	2,201 [25]	2,201 [24]	3,248 [85]	5,419 [208]
3	3,645 [107]	3,645 [107]	4,692 [167]	6,863 [291]

Table 2. Annual cost for different building and manure storage concept combinations

Building concept	Annual cost ($/year) [Increase compared to concepts 1 and A; %]			
	Manure storage concept			
	A	B	C	D
1	267,488 [0]	271,729 [2]	281,886 [5]	357,780 [34]
2	225,544 [-16]	229,785 [-14]	239,941 [-10]	315,835 [18]
3	266,949 [0]	271,190 [1]	281,346 [5]	357,240 [34]

Effect of Extender, Cooling Method and Incubation Time on Storage of Extended Boar Semen at 5°C

Murray Pettitt and Eduardo Beltranena

Summary

A study was carried out to determine if cooling method, incubation time and extender affected the success of storing boar semen at 5°C. Extended boar semen can be stored at 5°C with acceptable values of sperm progressive motility, total motility and viability over time. This success depends upon incubating the sperm at 17°C for at least 24 hours prior to 5°C storage.

Extended boar semen can be stored at 5°C with acceptable results.

Introduction

Extended boar semen is usually stored at a temperature of 17-18°C, but this temperature is difficult to maintain, especially during transport. Fluctuations in temperature during shipping or storage that affect the quality of the extended semen can often go unnoticed. Storing extended boar semen at 5°C would allow for the transport of semen using readily available cooling units.

A study to determine the effects of cooling method and incubation time on boar semen extended in three different extenders and stored at 5°C was carried out at PSC Elstow Research Farm Inc. The objectives of this project were to determine the effect of 1. three commercial extenders, and 2. stepwise cooling combined with different final incubation times at 17°C, on the ability to store extended boar semen at 5°C.

Experimental Procedures

Eighteen fresh ejaculates from 7 boars were split and 8 insemination doses (2 billion sperm, 70 mL each) were extended in each of three commercial extenders (Ext A, B and C) at 35°C. Within extender, each dose was subjected to one of eight cooling rate by incubation time treatment combinations:

Treatment	Cooling Method	Incubation	Final Storage Temperature
1	Stepwise 35 - 17°C	None	17°C
2	Stepwise 35 - 17°C	None	5°C
3	Stepwise 35 - 17°C	4 Hr @ 17°C	5°C
4	Stepwise 35 - 17°C	24 Hr @ 17°C	5°C
5	Direct 35 - 17°C	None	17°C
6	Direct 35 - 17°C	None	5°C
7	Direct 35 - 17°C	4 Hr @ 17°C	5°C
8	Direct 35 - 17°C	24 Hr @ 17°C	5°C

Stepwise cooling consisted of placing the 35°C extended semen into consecutive water baths at 32, 29, 25, 22, 19 and 17°C, changing the extended semen from one bath to the next every 30 min. For direct cooling, the semen doses were placed into a 17°C storage cabinet. Total motility (percentage of sperm moving), progressive motility (percentage of sperm moving in a forward fashion) and viability (percentage of living sperm), were measured on the extended semen samples for six consecutive days.

Results and Discussion

Extender has an effect on sperm motility. Progressive motilities were greater in extenders A and B than in C on day 1, but from day 2 on, progressive motilities were greater in extender A, intermediate in B and lower in C (Figure 1).

Progressive motilities in the 8 cooling rate/ incubation time treatments were typically the greatest in sperm stored at 17°C (Figure 2; Treatments 1 and 5) followed by sperm incubated at 17°C for 24 hr prior to storage at 5°C (Treatments 4 and 8). Cooling method (direct or stepwise) did not affect these results.

Total motility was lower in extender A and B than in C for days 1 through 5 and lower in extender A than B and C on day 6.

Total motility on day 1 was greater when sperm were stored at 17°C or incubated for 24 h at 17°C prior to storage at 5°C (Figure 3; Treatments 1, 5, 4 and 8), than when sperm were stored at 5°C or incubated for 4 h at 17°C prior to storage at 5°C (Treatments 2, 6, 3 and 7).

By day 2, total motilities were greatest for sperm stored at 17°C (Treatments 1 and 5), followed by sperm incubated for 24 hr at 17°C prior to storage at 5°C (Treatments 4 and 8), which in turn were followed by sperm incubated for 4 h at 17°C prior to storage at 5°C (Treatments 3 and 7). Sperm stored at 5°C (Treatments 2 and 6) had the lowest values for total motility and this pattern continued on through to day 6.

Extender A, regardless of cooling rate/ incubation time combination, maintained both progressive and total motility values at the greatest levels over time. When stored at 5°C without prior incubation at 17°C, total motility values were generally greater for sperm that had been cooled stepwise compared to those cooled directly. While total motility values were superior when sperm were stored at 17°C, acceptable total motility was possible when sperm were stored at 5°C but depended on a 24h incubation period at 17°C.

Viability results differed among the three extenders. In Extender A, viability on day 1 was greater for all cooling methods compared to sperm directly cooled and stored at 5°C (Treatment 6). By day 2 there were essentially no differences.

Viability in Extenders B and C was variable, with sperm stepwise or directly cooled and stored at 5°C without incubation (Treatments 2 and 6) usually yielding values among the lowest. Cooling method (direct or stepwise) did not affect viability in any of the three extenders.

Implications

These results indicate that extended boar semen can be stored at 5°C with acceptable values of sperm progressive motility, total motility and viability over time. Achieving these acceptable values at a storage temperature of 5°C depends upon incubating the sperm at 17°C for at least 24 hours prior to 5°C storage. Extender choice influences this success, as does incubation time, but only total motility was affected by a direct or stepwise cooling method. It is important to note that these are laboratory results and an insemination trial is required to confirm these laboratory findings prior to implementation in the field.

Acknowledgements

Funding from the Saskatchewan Agriculture and Food, Agriculture Development Fund is gratefully acknowledged.

***Figure 1:* Progressive Sperm Motility**

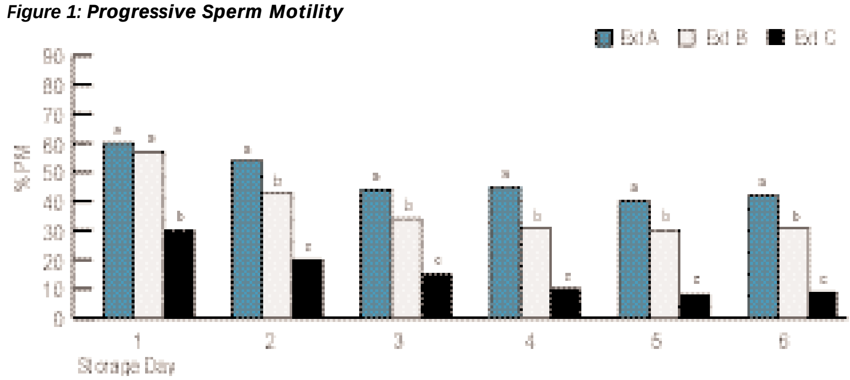


***Figure 2:* Progressive Sperm Motility**

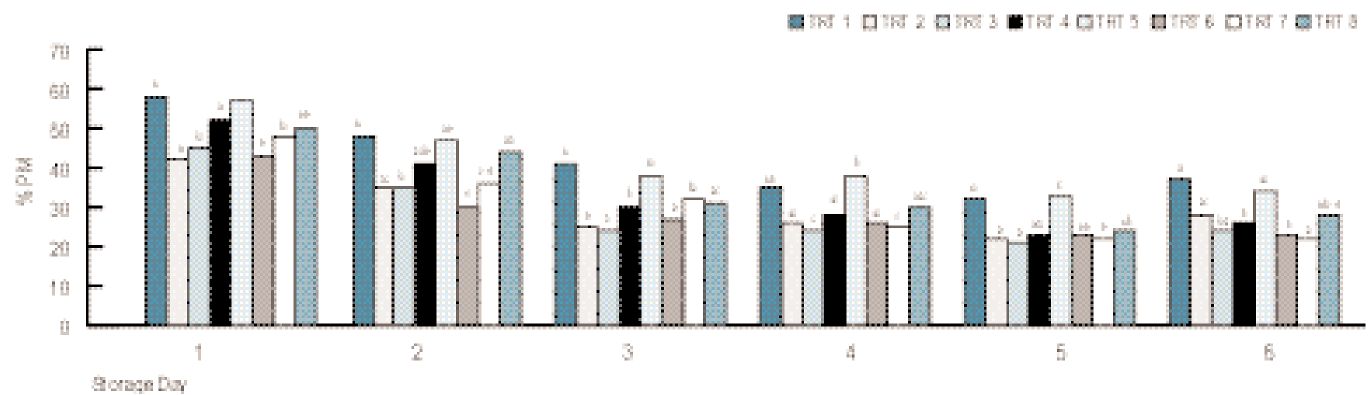
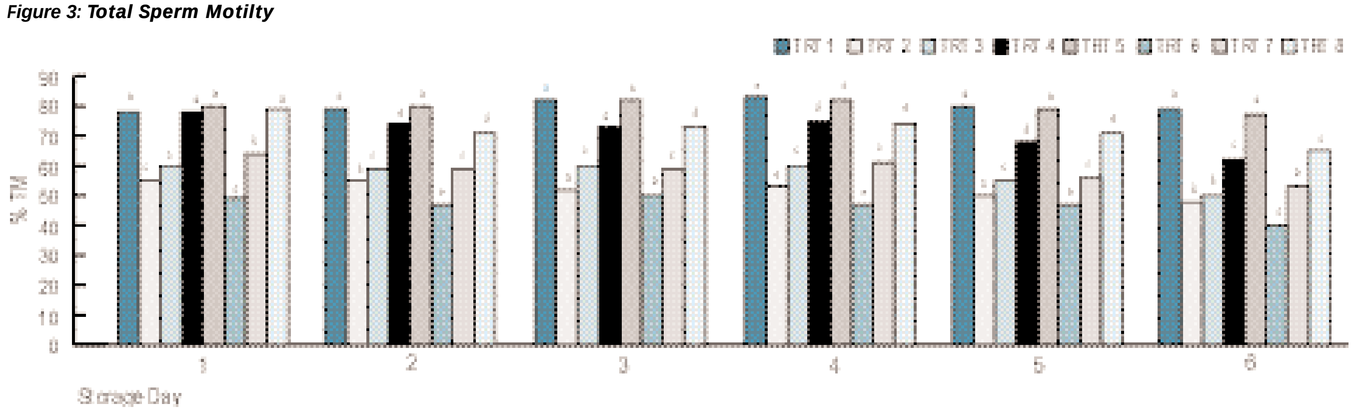


***Figure 3:* Total Sperm Motilty**



Draeger microPac Performance for Hydrogen Sulphide Monitoring in Commercial Swine Operations

Liliane Chénard, Stéphane Lemay, and Shala Christianson [1]

Summary

The swine industry needs reliable and affordable tools to monitor the air quality in the barn to ensure workers are fully aware of unsafe conditions. Sixteen Draeger microPac hydrogen sulfide (H_2S) monitors were followed over a year to determine the performance of the monitors. The monitors performed consistently under barn conditions with only a small average drift in the accuracy from 0.6 to 2.0 ppm. With a calibration every year, the Draeger microPac monitors are suitable for H_2S monitoring in swine barns.

Introduction

Until recently, systematic H_2S monitoring was not performed in the swine industry. A few incidents involving the detrimental effects of H_2S have increased the awareness of the possible hazards related to H_2S and more intensive swine operators want to ensure that their workers are provided with equipment to warn them of unsafe working environments. Monitors in swine buildings are subjected to a harsh environment where dust, humidity and gases may be present and the monitors may be subject to accidental falls on the concrete or in the manure. As a result, the swine production conditions are likely to challenge the H_2S monitor in a way the monitors have not previously experienced. The objective of this project was to evaluate the performance of the Draeger microPac unit (Figure 1) for H_2S monitoring in pig barns.

Experimental Procedures

Over the course of a year, four Draeger microPac monitors were used in office conditions as controls, and 12 monitors were used in both the PSC Floral and Elstow barns. The working conditions for each monitor that were in the barns was similar, including power washing and pit pulling. Eight of the monitors used in the barns were subjected to extreme tests after four and eight months of use; four monitors were dropped on concrete, and four monitors were dropped in the manure pits and recovered after 10 sec. A calibration gas was used to regularly check the accuracy drift of each of the monitors six times during the project.

Results and Discussion

The absolute average drift of all the monitors after 328 days was from 0.6 to 2.0 ppm, with an absolute maximum drift of 2.7 ppm. This maximum drift was much less than the maximum drift Draeger specified, which was 12 ppm after one year. There was a significant difference in the drift of the monitors after the first six months ($p<0.05$), but after six months, there was no significant drift of the monitor accuracy. There were also no significant differences between the monitors ($p>0.05$).

Draeger micoPac monitors, calibrated yearly, are good tools to warn workers of H_2S in pig barns.

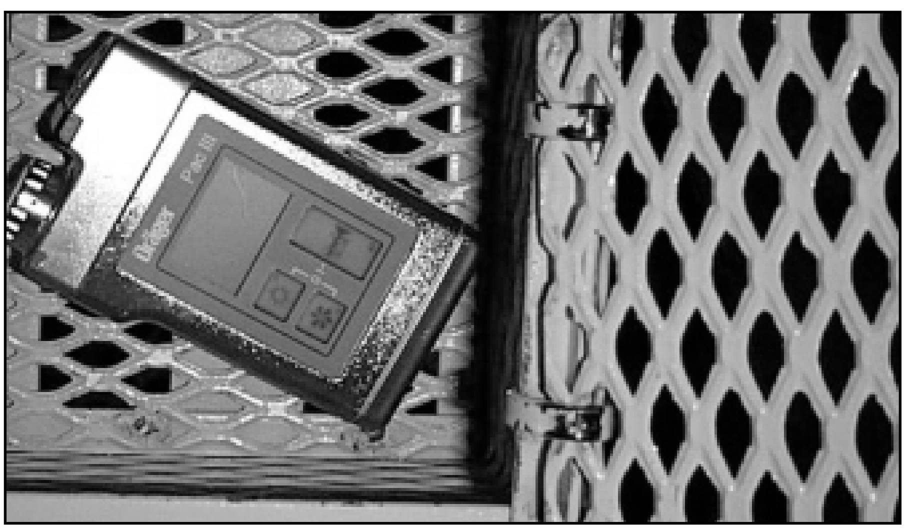


Figure 1: *Draeger microPac H_2S monitor.*

Implications

Draeger microPac monitors with a calibration every year are good tools to warn workers of high H_2S in swine barns. Any effects of repeated abuse on the monitors is unknown, but the monitors performed consistently under normal swine housing conditions, including dropping on concrete and into manure pits. The accuracy drift of the monitor was acceptable over one year without any monitor calibrations to help ensure safe working conditions in swine operations.

Acknowledgements

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by Draeger.

[1] PSC and Deptartment of Agricultural Engineering, U of S.

Hydrogen Sulphide Concentration While Pulling Pit Plugs and Power-Washing Rooms

Liliane Chénard, Stéphane Lemay, and Claude Laguë [1]

Summary

Six pig farms were studied to assess the barn worker exposure to hydrogen sulphide (H_2S) while pulling pit plugs and power-washing production rooms. Results indicate that plug pulling generated high concentrations of H_2S, reaching 1,000 ppm in some cases. All of the farms used in this study had plug pulling events that exceeded limits defined by the Occupational and Safety Regulations of Saskatchewan. The H_2S released when a plug was pulled did not follow a predictable pattern over time and within the room. Power washing generated lower H_2S concentrations than plug pulling but workers were exposed for a longer time period. Based on that study, swine barn workers may be exposed to H_2S concentrations that exceed acceptable limits when pulling pit plugs and power-washing. Personal monitors should be provided to all barn workers, training and standard operating procedures are needed so workers can learn how to deal with routine operations and emergency situations generating high H_2S concentrations.

All of the farms used in this study had events that released enough H_2S to pose a possible health risk.

Introduction

Hydrogen sulphide (H_2S) is a life threatening gas produced by the anaerobic degradation of liquid manure. As most swine barns are equipped with gutters accumulating manure, H_2S can be released when manure flows or is being mixed. Saskatchewan Labour regulates H_2S exposure in the Occupational Health and Safety Regulation and stipulates that a person should not be exposed to more than an average concentration of 10 ppm of H_2S for a period of eight hours (TWA: 8 hour time weighted average exposure limit) and an average of 15 ppm for a period of 15-min (STEL: 15-min time weighted average short term exposure limit). Saskatchewan Labour does not have a defined ceiling value for H_2S, but defines the level of H_2S immediately dangerous to life or health (IDLH) at 100 ppm – a level at which nobody should even be exposed to.

Recent events in Saskatchewan led us to believe that barn workers may be exposed to high H_2S concentrations while pulling pit plugs and power-washing rooms and monitoring was performed to evaluate this hypothesis.

Experimental Procedures

Six swine production sites were assessed to determine levels of H_2S exposure while workers performed specific manure management tasks in gestation, farrowing, nursery and grower-finisher rooms. The room concentration and distribution of H_2S were measured when pits were emptied (at the pit plug: 1 m from the floor level and within a 1 m radius of the plug). The concentration of H_2S was measured when workers were power washing rooms (worker chest level).

Results and Discussion

Results from four barns monitored in this study indicate that plug pulling generates high concentrations of H_2S. In some cases, the maximum recorded levels reached 1,000 ppm (Table 1). All of the farms used in this study had plug pulling events that could present health and safety risks to workers and exceeded limits defined by the Occupational

Table 1. Overall maximum H_2S concentrations obtained during the plug pulling events performed in the four farms and the number of events where the concentration obtained exceeded IDLH.

Barn section	Maximum H_2S concentration (ppm) [number of events with concentration higher than IDLH / total number of plug pulling events monitored]			
	Farm number			
	1	2	3	4
Farrowing	810 [7/7]	610 [5/8]	75 [0/8]	123 [1/8]
Gestation	1000* [6/7]	1000* [6/9]	79 [0/8]	66 [0/8]
Grow-Finish	202 [2/4]	494 [3/8]	452 [2/8]	61 [0/8]
Nursery	1000* [1/3]	280 [2/9]	69 [0/8]	51 [0/8]

* Maximum concentration that could be read by the H_2S sensor.

[1] Dean, College of Engineering, University of Saskatchewan

Health and Safety Regulations of Saskatchewan.

The H_2S released when a plug was pulled did not follow a predictable pattern (Figure 1). In some cases, the maximum value was reached within less than four minutes after the plug had been pulled. In others, the concentration increased and went through a number of intermediate peaks before reaching the maximum.

While most of the highest concentrations were generally recorded at the plug or sewer hole, sometimes it was recorded elsewhere in the room (Figure 2). No predictable distribution pattern was observed for a specific location where the peak would be reached.

Power washing generated lower H_2S concentrations than plug pulling. As power washing generally takes time, in some cases, the STEL was reached shortly after the task started and was exceeded for a long period of time, which in some of the monitored events was more than 30 minutes.

Implications

Swine barn workers may be exposed to H_2S concentrations that exceed acceptable limits when pulling pit plugs and power-washing rooms. Locations of peak H_2S concentrations vary within the room. A worker pulling the plug and walking away from it may not be in a safer position if staying in the room, and the same comment applies to a bystander. Monitors should be provided to all swine barn workers as H_2S may be present in other areas than where the plug is pulled (ex: transfer pit room, plug popping situations). Training and standard operating procedures are needed so workers can learn how to deal with routine operation and emergency situations generating high H_2S concentrations. Further research is needed to improve the design of swine buildings and manure management systems to prevent H_2S exposure.

Acknowledgements

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by SaskPork.

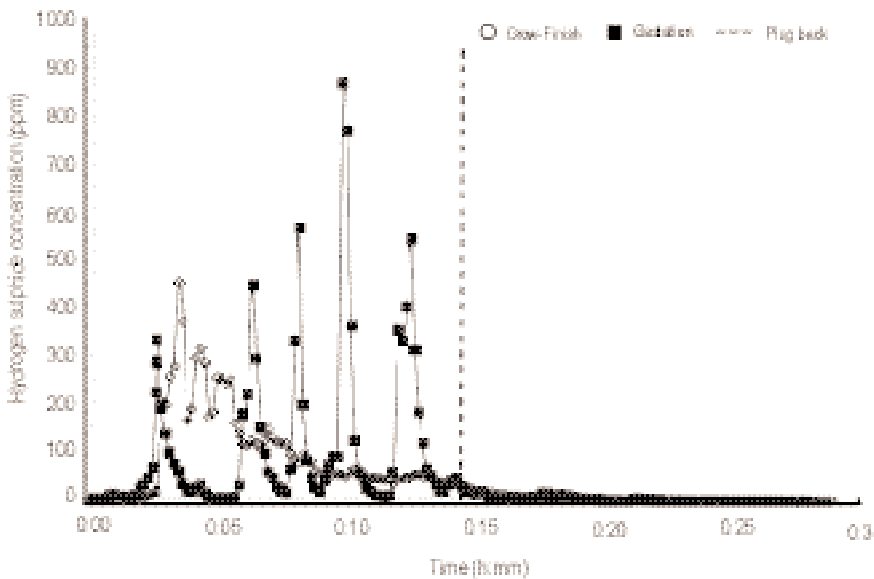


Figure 1: *Hydrogen sulphide concentration during plug pulling events performed in a grower-finisher room and a gestation room during the summer and winter period, respectively.*

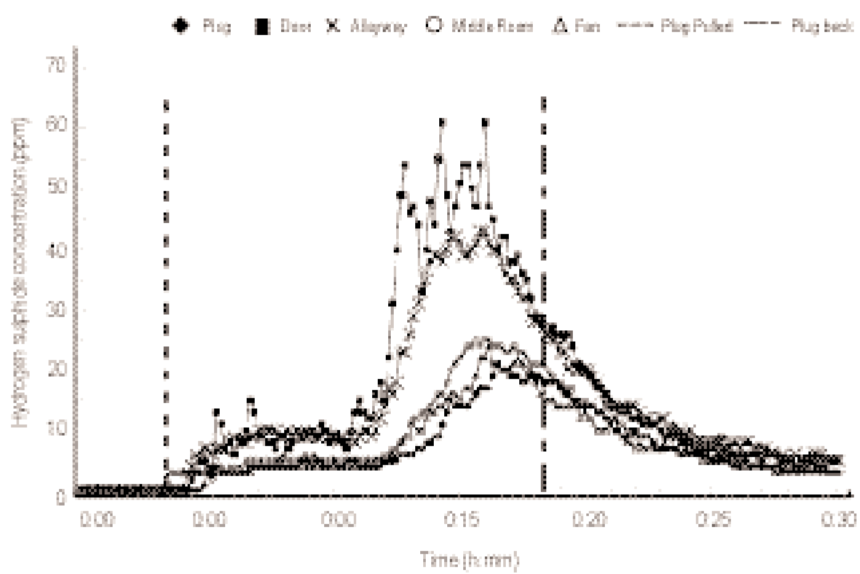


Figure 2: *Hydrogen sulphide concentration distribution within the room during a plug-pulling event in a grower-finisher room during the summer period.*

Effects of Large Group Size on Productivity of Grower-Finisher Pigs

Thusith Samarakone and Harold Gonyou

Introduction

Traditionally, pigs in North America are penned in groups of 10-40 animals. Over the past few years the concept of "large groups" has become more common with group sizes of 50-100 pigs/pen or even more, as a management strategy to reduce housing cost, improve space use and increase overall profitability. However, there are concerns that social instability in large groups may result in poor growth, higher mortality and morbidity and higher variation in body weights at the end of production.

The present study was aimed at comparing the production performance of grower-finisher pigs formed into a larger group (108 pigs/pen) to a conventional small group size (18 pigs/pen) and to see if this trend in the pig industry is beneficial to producers.

Large group size has little effect on pig performance.

Experimental Procedures

Eight 11-week trials of four groups of 18 (small group) and two groups of 108 grower-finisher pigs (large group) per pen were evaluated. Equal numbers of barrows and gilts (1:1) were used in each group. Initial body weight and body weight variation (CV) were 31.9 kg and 14.8% and 31.6 kg and 15.7% for small and large groups respectively. One wet/dry ad-libitum feeder space was provided for every nine pigs. Floor space per pig in the fully slatted rooms was identical between the two group sizes.

Average daily feed intakes (ADFI) were recorded for four trials during two experimental periods (week 2 to 5 and week 7 to 11). Body weight variation within the group (CV) at the end of each trial, average daily gain (ADG) and pig mortality and morbidity were determined for all eight trials.

Results

Pigs in smaller groups had a higher growth rate (10%, $P < 0.05$) during first 2-week period. ADG for the entire grower-finisher period was slightly higher (2%, $P < 0.05$) for the pigs in the smaller groups compared to larger groups (Figure1).

ADFI during week 2-5 and week 7-11 was similar between the two group sizes (Figure 2) and no difference was observed on feed efficiency for the above two periods.

At the end of the experimental period, variation in pig body weight within a group (CV) was similar between the two groups (9.6% vs. 10.3% for small and large groups respectively).

No significant differences were observed between the two group sizes on percentage pigs removed (Figure 3).

Implications

Although pigs in larger group size tend to have a slight reduction in overall ADG, in general, the performance of the pigs in larger group size was not inferior to the smaller group size evaluated in this study during the grower-finisher period.

Acknowledgements

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Additional funding for this project was provided by NSERC.

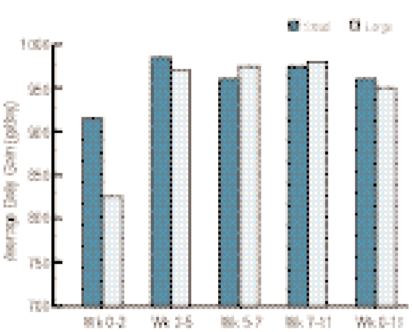


Figure 1: Effect of group size on ADG

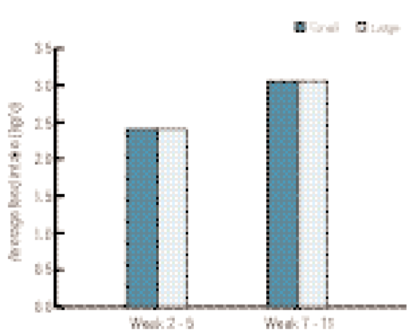


Figure 2: Effect of group size on ADFI

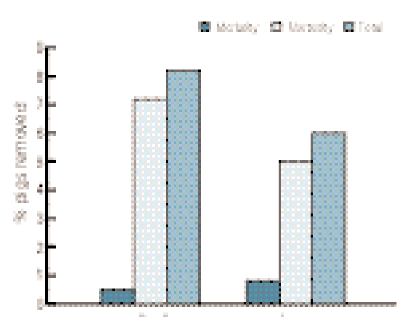


Figure 3: Effect of group size on percentage of pigs removed.

Growth Rate and Age at First Estrus: Impact on Managing the Gilt Pool

Jennifer Patterson, George Foxcroft [1], Murray Pettitt, and Eduardo Beltranena

Introduction

Identifying "select"(cyclic) gilts below market weight and achieving appropriate weights at first breeding are two essential features of efficient gilt management systems. To attain these two goals, early stimulation with boars to induce first estrus is an important management tool. However, for various reasons, producers delay inducing first estrus (puberty) until 180 to 240 days of age, even though replacement gilts reared under commercial conditions are quite capable of reaching market weight (115 - 120 kg) before 170 days of age. Retention of non-select gilts once they have reached market weight results in a financial penalty to the producer. Unnecessary delays in stimulating pubertal estrus and breeding gilts increases feed, barn space and labour costs and may cause welfare problems because of increased physical size of mature sows.

Early stimlulation with boars to induce first estrus is common, but waiting too long can carry a financial penalty.

Experimental Procedure

Prepubertal Camborough 22 and L42 gilts (N = 509; PIC Canada Ltd) were allocated to the study at 101.3 ± 5.7 d of age and 60.3 ± 8.8 kg (mean ± SD) body weight. The gilts had ad libitum access to feed and water, were housed in groups of twenty and received 20 minutes direct exposure to an epididimectomized boar daily, starting at 140.0 ± 4.7 d of age. Gilts were deemed to be non-select if pubertal estrus had not been observed by 180 d of age. Select gilts were bred at third estrus, regardless of age or weight.

Results

Our results confirm that at commercially acceptable growth rates (0.55 – 0.80 kg/d) there is no relationship between growth rate (birth to 100 days of age) and age at puberty (r=0.079, P=0.15). As a consequence, inherent differences in age at puberty (Early, Intermediate, Late, Non-responders) affected days from first stimulation to first estrus or designation as non-select, and weight, backfat depth and growth rate at puberty (Table 1).

Implications

Figure 1 illustrates the overall distribution of the age of the gilts that reached puberty. Overall, out of 509 gilts, 59% of all gilts reached puberty within 30 days of stimulation, 77% of gilts were pubertal within 40 days of stimulation and 23% of gilts were considered non-pubertal at 40 days of stimulation (Figure 1). Based on these results, we estimate that if early pubertal stimulation is used as a "selection" technique, 120% of breeding gilt requirements should enter the stimulation phase (expecting 20% not to cycle) to obtain the required number of gilts cycling within 40d.

At 180 days of age, 23% of all glilts were non-pubertal, and nearly 80% of these were above market weight – a possible financial liability.

An important point that producers should consider is the weight of the gilts considered non-responders at 180 days of age (Figure 2). Overall, 23% of all gilts were considered non

Table 1. Characteristics measured at the onset of puberty (1st estrus)

	Early	Intermediate	Late	Non-Responders[†]	SEM	Group *P*-Value [1]	Sow *P*-Value [2]
#, Gilts	104	161	114	112	-	-	-
Pubertal Age (d)[*]	148.5 [a]	159.7 [b]	175.3 [c]	*(>180)*	0.81	0.0001	0.0289
Days to Puberty (d)	8.5 [a]	19.6 [b]	35.2 [c]	*(>40)*	0.82	0.0001	0.0364
Weight (kg)	106.1 [a]	118.0 [b]	128.3 [c]	131.3 [c]	2.0	0.0001	0.0001
Backfat Depth (mm)	12.7	13.7	13.7	13.5	0.45	0.2366	0.0001
Growth Rate (kg/d)	0.688 [a]	0.718 [b]	0.722 [b]	0.729 [b]	0.009	0.0014	0.0001

[†] Average age of non-responders was 179.7 days at the time of removal from the experiment.
[*] Puberty is defined as the first day a gilt exhibits the standing reflex in the presence of a boar.
[1] Group defined as the difference between early, intermediate, late and non-responders.
[2] Sow defined as the differences between dam at birth.

[1] University of Alberta

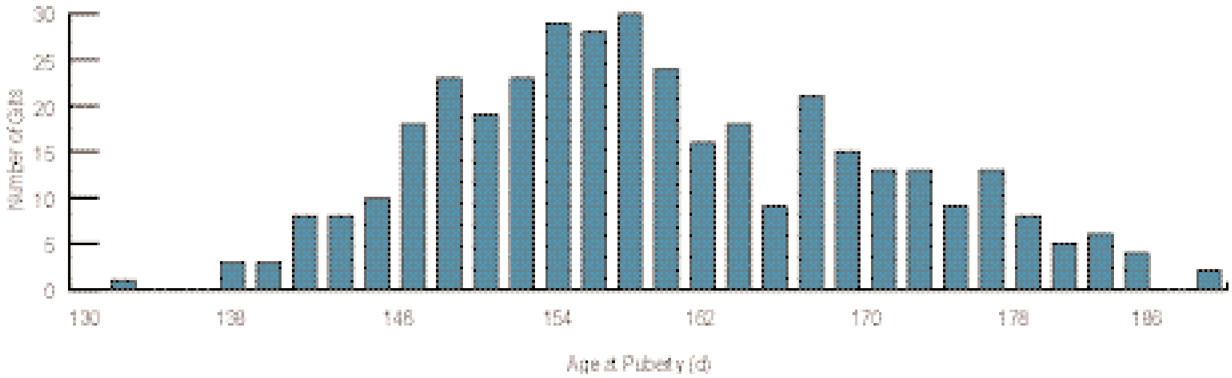


Figure 1: *The distribution of gilts reaching puberty*

pubertal and nearly 80% of these were above market weight (120 kg), thus resulting in a financial penalty to the producer if these gilts were to be removed as market animals.

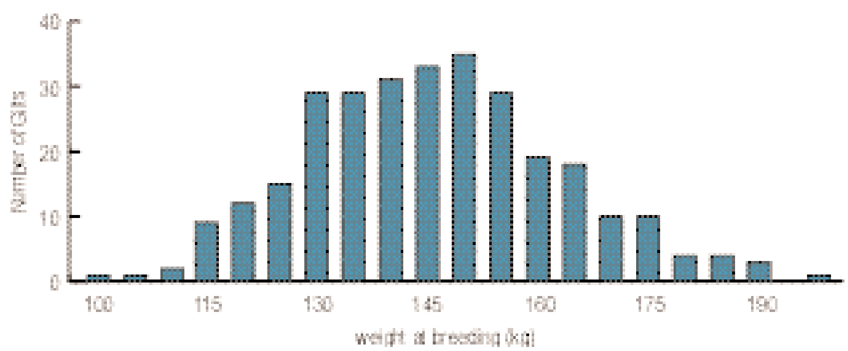


Figure 2: *The weight of non-responders at 180d of age (n=88)*

Acknowledgements

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Development Fund (ADF). Direct funding for this project was provided by SaskPork, ADF, Alberta Pork and AARI.

Feed Processing and Nutritional Quality Among Wheat Classes Fed to Weaned Pigs

Ruurd Zijlstra, David Overend [1], David Hickling [2], P. Howard Simmins [3], and John Patience

Summary

Feed processing and nutritional quality for CPS and durum wheats have traditionally been expected to be lower than for Hard Red Spring (HRS). Performance of weaned pigs was compared among six wheat classes, whilst considering particle size and diet pellet quality. Results indicated that feed processing quality and growth performance did not differ among wheat classes. Weaned pigs fed various classes of wheat including CPS and durum may grow similarly.

Introduction

The processing and nutritional quality of wheat is expected to vary among classes; CPS and durum wheat are currently segregated. A range in wheat protein and fibre or non-starch polysaccharide (NSP) content may partly cause quality variation. The present study was designed to test whether wheat class by itself impacts feed processing or nutritional quality.

Experimental Procedures

Two cultivars from each of six classes (CPS White and Red, HRS, durum, Hard Red Winter (HRW) and Hard White (HW)) were collected (Table 1). Protein ranged from 12.2 to 17.4% and total NSP from 9.0 to 11.5% (Table 2). A 3-week growth and digestibility study was conducted with 12-kg weaned pigs (PIC; 39-day-old; 4 pigs/pen, 12 pens per cultivar), which were fed pelleted 65%-wheat diets (3.5 Mcal DE/kg; 3.4 g dig. lysine/Mcal).

Results and Discussion

Wheat particle size ranged from 536 to 734 mm (10/64"-screen) (Table 2). Pellet Durability Index was 96 for all diets. Feed processing quality was thus excellent for all wheat classes. In the growth study, average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency did not differ among wheat classes for day 0 to 21 (Figure 1). However, some minor differences were observed in the first week. For example, ADG for durum was 9% lower than for HRW, and similar among other classes; ADFI for HW was 7% lower than for HRW, and similar among other classes. Finally, diet energy digestibility (and thus DE content) was lowest for CPS Red (86.5%), medium for CPS White, HRS and HW (87.2 to 87.5%) and highest for HRW and Durum (88.6 & 88.9%) (Figure 2).

Implications

Protein but not NSP content varied among 12 wheat cultivars harvested in western Canada in 2001. Wheat protein content was "corrected for" during diet formulation and did not affect pig performance. Wheat NSP content was low overall, indicating that all 12 wheat samples were of excellent nutritional quality. Still, DE content ranged 7% and was highest for durum. Reductions in ADG and ADFI for CPS and durum wheat were limited to the first two weeks, and did not exist after three weeks.

In conclusion, despite variations in wheat DE content, weaned pigs fed various classes of wheat including CPS and durum performed equally. Wheat class by itself was not a cause for a range in feed processing or nutritional quality.

Acknowledgements

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council, and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by the Canadian Wheat Board, Canadian International Grains Institute, Feed-Rite (Ridley Inc.), Danisco Animal Nutrition, Degussa, and Quality Assured Seeds.

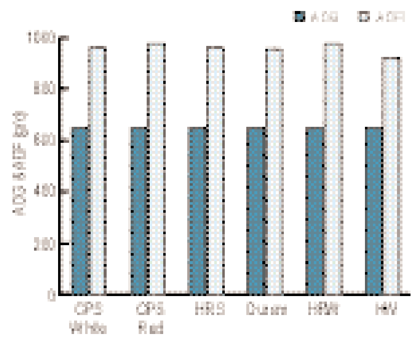


Figure 1: *Effects of wheat class on average daily gain (ADG) and feed intake (ADFI) of weaned pigs in the 3-week growth study.*

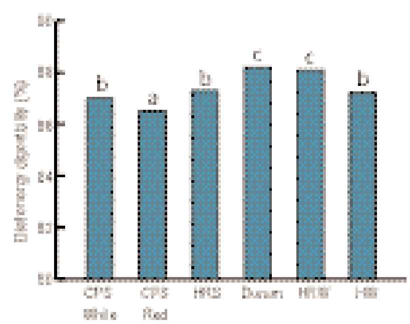


Figure 2: *Effect of wheat class on diet energy digestibility measured in weaned pigs.*

Table 1. The Canadian Wheat Board classes and popular names for the used wheats.

Canadian Wheat Board Class	Popular Name
Canadian Prairie Spring White	CPS White
Canadian Prairie Spring Red	CPS Red
Canadian Western Red Spring	Hard Red Spring (HRS)
Canadian Western Amber Durum	Durum
Canadian Western Red Winter	Hard Red Winter (HRW)
Canadian Western Hard White	Hard White (HW)

Table 2. Protein and NSP content and particle size of the ground wheat. Each value represents one of two cultivars per class.

Wheat class	Protein (% as is)	Total NSP (% as is)	Particle size (% as is)
CPS White	15.1,16,1	11.3,11.4	591,700
CPS Red	12.4,15.8	11.0,11.3	556,631
HRS	15.4,17.1	10.8,16.5	640,708
Durum	16.3,16.8	9.0,10.1	624,734
HRW	12.2,13.7	9.7,10.9	536,636
HW	16.5,17.4	10.9,11.3	629,724

[1] Ridley Inc., Mankato, MN
[2] Canadian International Brains Institute, Winnipeg, MB; presently Canola Council of Canada, Winnipeg, MB
[3] Danisco Animal Nutrition, Marlborough, UK

Reducing Water Waste From Nipple Drinkers by Growing-Finishing Pigs

Yuzhi Li and Harold Gonyou

Summary

Growing/finishing pigs can maintain adequate water intake from a variety of drinker types and drinker management protocols. However, water waste from drinkers can be very different depending on drinker type and management. Well-managed nipple drinkers can reduce water waste to the same level as bowl drinkers.

Introduction

Our previous study indicated water waste from a nipple drinker could be 40% of water disappearance when the drinker was never raised, rather than being adjusted to a recommended level (2.5 cm above pig shouder). Keeping the drinker height at the recommended level for growing/finishing pigs means the drinker has to be adjusted as the pigs grow. This is rarely done on commercial farms. A new setup of nipple drinkers was used to maintain the drinker at the recommended level for pigs throughout the whole growout period without adjusting its height. Productivity, water use, manure output, and drinking behaviour were compared among pigs from different types and management of drinkers to test the feasibility of the new setup.

Experimental Procedures

Sixteen pens of 18 pigs in a grower/finisher room were used for the 12-wk study. Four types of drinker systems were tested: improved nipple drinkers (new setup), well-managed nipple drinkers, conventional nipple drinkers, and bowl drinkers. The improved nipple drinker was set at 73 cm of height, which is the recommended nipple height for pigs at the body weight of 100 kg. In order to allow the young pigs to reach the nipple drinker, a step was placed beneath the drinker. The height of the step was 25 cm, so the distance between the nipple and the top of the step was 48 cm; that is the recommended nipple height for pigs of 25 kg. The well-managed nipple drinker was adjusted to the recommended height every two weeks according to body weight of the pigs. The conventional nipple drinkers and bowl drinkers were mounted at the height of 48 cm, and not adjusted throughout the whole growing/finishing period as on many commercial farms. Four pens were randomly assigned to each of the drinker treatments. Growth rate, water disappearance, manure output, and drinking behaviour were determined.

Results and Discussion

Final body weight, variations in final body weight, and growth rate were similar among pigs on different drinkers (Table 1). Water disappearance from pigs on the bowl drinkers was lower than pigs on other drinkers during the growing period (Table 1). However, during finishing period, water disappearance for pigs on the bowl drinkers was as high as conventional nipple drinker. The overall water disappearance from pigs on the improved nipple drinkers was similar as those on the well-managed nipple drinkers and bowl drinkers. In comparison with pigs on the conventional nipple drinkers, water disappearance from pigs on the improved nipple drinkers was reduced by 13%. Daily manure output from pigs at different drinkers was similar during the first 4 weeks (Figure 1). Pigs on the conventional nipple drinkers and bowl drinkers produced more manure from wk 4 and wk 8, respectively. The overall average daily manure output from pigs on the improved nipple drinkers was 10% lower than that on conventional nipple drinkers, but similar to those on the well-managed nipples and bowl drinkers. Pigs spent more time drinking from bowl drinkers. Pigs on the improved nipple drinkers spent similar time drinking as those on the well-managed nipple drinkers.

Table 1. Initial and final body weight, coefficient of variation, and water disappearance of growing/finishing pigs at different drinkers.

Item	Bowl	Conventional nipple	Well-managed nipple	improved nipple	SEM	P <
Initial						
BW, kg	31.5	31.8	31.7	32.1	0.67	NS*
CV, %	13.3	16.3	14.5	12.8	1.21	NS
Final						
BW, kg	104.2	106.0	102.9	104.0	1.98	NS
CV, %	10.8	10.6	10.5	10.8	1.18	NS
Water disappearance, L/pig/d						
Wk 0-4	4.36 [a]	5.41 [b]	5.46 [b]	4.79 [ab]	0.241	0.01
Wk 4-8	6.51 [a]	7.56 [b]	6.89 [bc]	6.61 [ac]	0.293	0.06
Wk 8-12	7.88 [b]	7.84 [b]	6.87 [a]	6.68 [a]	0.345	0.05
Wk0-12	6.25 [a]	6.94 [b]	6.40 [ab]	6.03 [a]	0.247	0.08

BW = average body weight of pigs, CV = coefficient of variation.

*NS = no significant difference ($P > 0.10$).

a,b,c Within a row, means without a common superscript letter differ ($P < 0.05$).

Implications

The new setup of nipple drinkers could reduce water wastage without impairing pig performance and drinking behaviour.

Acknowledgements

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Additional funding for this project was provided by NSERC.

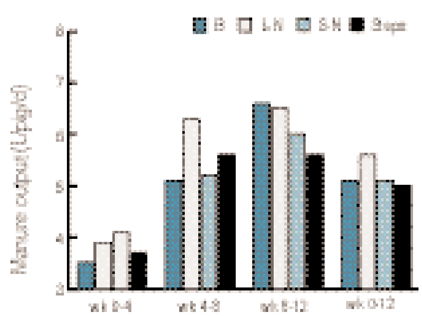


Figure 1: *Manure output from growing/finishing pigs at different drinkers. B = bowl drinker, L-N = conventional nipple drinker (nipple height set up at 48cm), S-N = well-managed nipple drinker (height of nipple drinker adjusted according to pig weight), Steps = improved nipple drinker (nipple drinker with step underneath).*

Water Usage by Grower-Finisher Pigs Using Dry and Wet/Dry Feeders

Shala Christianson [1], Stéphane Lemay, Claude Laguë [2], John Patience, and Harold Gonyou.

Summary

Water conservation is a growing concern in intensive swine operations (ISOs) for both financial and environmental reasons. The water usage of a grower-finisher room in an ISO was measured using dry and wet/dry feeders. The major source and sink of water was at the drinker and in the manure, respectively. In addition, water disappearance and manure volume were reduced from 9.3 to 6.2 and from 8.9 to 5.4 kg water/pig-day, respectively, when wet/dry feeders were used in place of dry feeders. Therefore, wet/dry feeders are an effective alternative for reducing water usage and manure volume of grower-finisher barns.

Introduction

To address water conservation in intensive swine operations, the significant sources and sinks of water (water balance) need to be identified to know where to focus research efforts. Previous studies have shown that use of wet/dry feeders in place of dry feeders has potential water savings. The objective of this study was to systematically measure and report the water usage of grower-finisher swine using dry and wet/dry feeders.

Experimental Procedures

Six separate grower-finisher cycles were followed and the parameters of water usage, including water from the drinkers, in the feed, metabolic reactions within the pig, ventilated from the room and in the manure, were measured for each cycle.

Results and Discussion

Table 1 presents a summary of the average values for the water balance measured over the six cycles. The significant source and sink of water was at the drinker, at 72% of the total water source, and in the slurry, at 64% of the total water sink, respectively. The use of wet/dry feeders compared to dry feeders significantly reduced both the water disappearance at the drinker by up to 34% ($p<0.05$), as seen in Figure 1, and the volume of the slurry by up to 29% ($p<0.05$) for finisher pigs.

Pig performance was not significantly different for dry and wet/dry feeders ($p>0.05$), although by the end of the finisher phase, the pigs on wet/dry feeders were generally 5% larger than the pigs on the dry feeders. The feed conversions (FC) were similar for pigs on both dry and wet/dry feeders, with the FC being slightly higher for pigs on wet/dry feeders.

Wet dry feeders reduced water disappearance by 34% and volume of slurry by 29%.

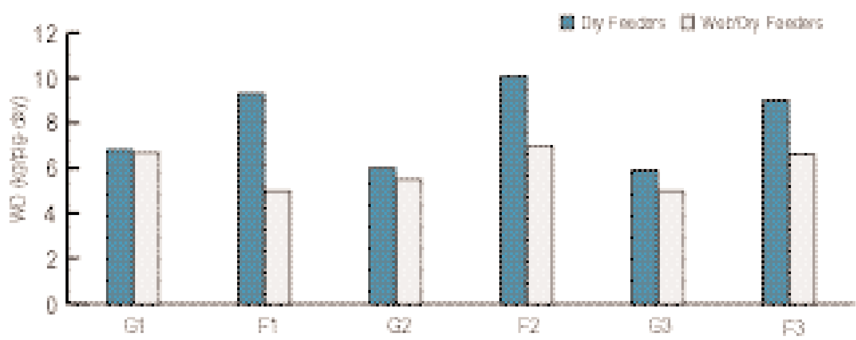


Figure 1: *Average water disappearance (WD) for all grower (G1, G2 and G3) and finisher (F1, F2 and F3) trials.*

Table 1. Summary of average water balance over three grower-finisher cycles.

Water Usage Components	Parameters	Water (kg/pig-day) Grower Dry*	Grower Wet/Dry**	Finisher Dry	Finisher Wet/Dry
Inputs	Water Disappearance	6.0	5.4	9.3	6.2
	Feed Water	0.3	0.3	0.5	0.5
	Metabolic Water	1.0	1.0	1.6	1.6
Outputs	Manure Water	-5.5	-4.4	-8.9	-5.4
	Pig Water	-0.4	-0.4	-0.7	-0.7
	Ventilated Water	-2.6	-2.7	-4.1	-3.4
Error		1.3	0.8	2.2	1.3

* Dry: dry feeder ** Wet/Dry: wet/dry feeders.

Implications

Future research on water conservation in an ISO should focus on the drinker and on the manure. Use of wet/dry feeders versus dry feeders generally resulted in less water being used and less manure to handle, decreasing the water usage and storage and handling costs.

Acknowledgements

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by the Natural Sciences and Engineering Research Council of Canada (NSERC).

[1] PSC and Department of Agricultural and Bioresource Engineering, University of Saskatchewan
[2] Dean, College of Engineering, University of Saskatchewan

The Effect of Dietary Energy Concentration and Lysine: Energy Ratio on the Growth Performance of Weaned Pigs.

Temi Oresanya, A.Denise Beaulieu, and John Patience

Summary

Amino acids should be included in the diet in proportion to energy content to ensure adequate intake. The results of this experiment indicate the optimum ratio for pigs growing from 7.5 to 22 kg is 4.65 g total lysine/Mcal DE. This is higher than most previous recommendations. Increasing dietary energy did not improve pig performance. The most economical diet for weanling pigs will change as market prices and ingredient costs change.

Introduction

Improvements in lean growth potential and health status of pigs has greatly increased expected pig performance. Hence a re-evaluation of amino acid requirements is needed. There is no consensus on the lysine requirement and the ratio of lysine/DE for weaned pigs. For example, current recommended ratios vary from 2.8 to 5.0 g total lysine/Mcal DE. The optimum level of lysine may differ from the maximal, depending on economic circumstances in the pork industry at any point in time.

Experimental Procedures

Two levels of digestible energy (DE); low energy (LE, 3.4 Mcal DE/kg) or high energy (HE, 3.6 Mcal DE/kg), at five lysine:DE ratios (3.7, 4.0, 4.3, 4.6, and 4.9 g total lysine/Mcal, DE) were investigated. Each of the 10 diets were fed to six pens of four pigs each (two barrows and two gilts) for four weeks starting one week after weaning at 20 days of age. The total lysine in the diets ranged from 1.25 to 1.66% for LE diets, and from 1.35 to 1.76% for HE diets . Body weight and feed disappearance were measured weekly. Regression analysis was conducted to determine the relationship between lysine:DE ratios and pig performance.

Results and Discussion

Average daily gain increased with increasing lysine:DE ratio (quadratic, $P < 0.10$) and ranged from 515 to 554 g/d (d 0 to 28; Figure 1). Feed efficiency was improved with increasing lysine:DE ratio and DE ($P < 0.01$; Table 1). We concluded that the total lysine:DE ratio that maximized ADG was 4.65 g/Mcal DE. This is equivalent to 1.6% total lysine in the diet, if the diet contains 3.45 Mcal DE/kg, typical of the commercial industry. Increasing diet DE content had no effect on average daily gain ($P > 0.10$), but did reduce feed intake by 4%.

Weaning pigs responded to lysine levels up to 1.6%, however the optimal ratio will depend on market conditions.

Implications

The lysine level selected for commercial use will depend on economic conditions. If pork market prices are above $1.75/kg, the ratio that is economically most advantageous for commercial production would be 4.3 g/Mcal, equal to 1.5% of the diet. If the market price is very weak, the optimum lysine:DE ratio would fall to 3.8 to 4.1, equal to 1.3% or 1.4% of the diet.

As found in previous experiments, ADG was unaffected by DE. As expected, increasing DE lowered feed intake and thus slightly ($P < 0.01$) improved feed efficiency. Given that the cost of increasing dietary DE from 3.4 to 3.6 Mcal/kg is currently $25/tonne, reducing the DE content of a starter diet from the higher to the lower DE level would reduce feed cost from $8.73 to $7.83 per head, a savings of $0.90 per head.

Acknowledgements

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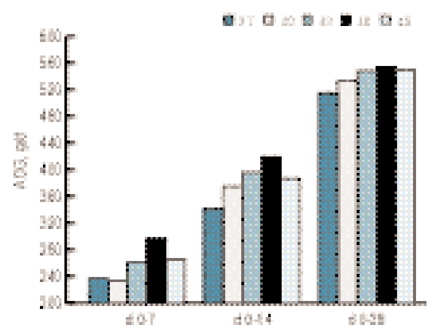

Figure 1: *The effect of lysine/DE ratio on ADG of young pigs growing from 7.5 to 22.5 kg ($P < 0.05$; all periods).*

Table 1. The effect of DE concentration and lysine/DE on body weight, feed intake and feed efficiency

	DE, Mcal/kg		Lysine/DE, g/Mcal					SEM
	3.4	3.6	3.7	4.0	4.3	4.6	4.9	
Initial Wt, kg	7.47	7.47	7.45	7.48	7.43	7.55	7.46	0.07
Final Wt, kg [1]	22.49	22.57	21.84	22.16	22.71	23.13	22.82	0.21
ADG	539	540	515	533	548	554	549	10.0
ADFI, g/d [2]	856	826	842	857	850	839	817	10.0
Gain:Feed [1]	0.63	0.66	0.61	0.61	0.65	0.66	0.67	0.01

[1] Effect of lysine/DE ratio ($P < 0.01$)

[2] Effect of DE concentration ($P < 0.01$)

The Peformance of Growing-Finishing Pigs Fed Diets with Reduced Crude Protein

John Patience, A. Denise Beaulieu, Ruurd Zijlstra, Doug Gillis, and James Usry [1]

Summary

Successful formulation of low protein diets increases our flexibility in formulating practical diets, providing us with another tool to lower nitrogen output in the slurry and to reduce greenhouse gas emissions. This experiment compared the performance of pigs fed regular protein versus low protein diets. An intermediate protein diet was also employed.

Average daily gain, average daily feed intake and feed efficiency were unaffected by dietary treatment. Most carcass characteristics, including index, lean yield and backfat thickness were unaffected by treatment; however, loin muscle thickness was increased on the low protein diet. Lower crude protein diets can be fed successfully without negatively impacting performance or carcass quality.

Introduction

There is increasing interest in formulating diets with lower crude protein content. The declining cost of synthetic amino acids, a desire to minimize the nitrogen content in the slurry and an interest in reducing greenhouse gases all contribute to this interest. However, in the past, low crude protein diets sometimes reduced growth performance and often resulted in fatter carcasses.

Experimental Procedures

This experiment employed three dietary treatments (Table 1). The control diet was formulated to contain a level of crude protein that required no more than 0.1% L-Lysine HCl to meet the pig's requirement for lysine, i.e. a typical diet used by the pork industry today. The low protein diet was formulated with the lowest possible crude protein level without using any synthetic L-tryptophan. In other words, levels of L-lysine HCl, DL-methionine and L-threonine were allowed to float in order to meet the pig's requirement for these three essential amino acids. However, synthetic L-tryptophan was not included in the formulation. This resulted in diets that contained as much as 3.5 kg L-lysine HCl, 1.4 kg L-threonine and 40 g DL-methionine per tonne of complete feed. These levels are clearly well above current commercial practice. A third diet was formulated to be intermediate in crude protein level between the other two. Diets were formulated to maintain a constant NE:Lysine ratio and equal levels of minerals and vitamins. Dietary electrolyte balance was similar across treatments.

There were a total of five pens and 110 pigs per treatment for a total of 660 pigs (330 gilts and 330 barrows). All pigs were housed in fully slatted concrete floored pens measuring 5.8 X 2.4 m. with spindle penning dividers. Pigs were housed 22 to a pen, providing 0.65 m^2/pig. Pigs were on test from 30 kg to 115 kg.

Results and Discussion

Overall, performance was excellent, with growth rates averaging 959 g/d. Feed conversion was also a very good 0.359, or 2.79:1. The uniformity of performance was also very good, with the SEM for daily gain only 8 g/d and for feed intake only 25 g/d.

There were no significant effects of crude protein on average daily gain, average daily feed or feed efficiency ($P>0.10$). However, there was a significant interaction between treatment and days on test ($P<0.05$).

Reducing crude protein had no negative effects on carcass quality; surprisingly, the lowest crude protein diet resulted in the thickest loin ($P<0.05$). Premiums were higher on the low protein diet (Table 3) as was the returns over feed cost. The feed cost considers the cost of the diet and days on test, which increased as dietary crude protein decreased. As expected,

Table 1. Composition of the experimental diets[1]

	Treatment					
	High		Medium		Low	
	Male	Female	Male	Female	Male	Female
	35 – 60 kg					
Wheat	43.990		47.672		51.365	
Soybean meal HP	26.144		22.510		18.870	
Barley	25.000		25.000		25.000	
L-Lysine•HCl	0.090		0.178		0.265	
L-threonine	--		0.037		0.074	
DL-Methionine	--		0.011		0.021	
	60 – 90 kg					
Wheat	52.021	46.993	55.254	52.755	58.490	58.521
Soybean meal	HP18.199	22.593	14.761	16.904	11.322	11.214
Barley	26.000	26.000	26.000	26.000	26.000	26.000
L-Lysine•HCl	0.098	0.039	0.192	0.193	0.286	0.347
L-threonine	--	--	0.068	0.066	0.136	0.132
DL-Methionine	--	--	0.015	0.020	0.029	0.040
	90 – 115 kg					
Wheat	21.282	29.875	26.011	34.158	30.743	38.446
Soybean meal	HP14.620	15.720	10.066	11.385	5.512	7.049
Barley	60.000	50.000	60.000	50.000	60.000	50.000
L-Lysine•HCl	0.080	0.108	0.203	0.226	0.325	0.343
L-threnine	--	--	0.045	0.051	0.089	0.101
DL-Methionine	--	--	0.005	0.016	0.009	0.032

[1] Diets also contained canola oil, dicalcium phosphate, limestone, vitamin and mineral premix, salt and sodium bicarbonate. Net energy, net energy:lysine ratio, minerals and vitamins were constant across treatments.

[1] Ajinomoto Heartland Inc., Chicago IL, USA.

gilts indexed higher than barrows (111.9 vs. 109.7), with higher lean yield (60.4% vs 59.2%), less backfat (19.1 mm vs 21.4 mm), a thicker loin (61.6 mm vs 59.0 mm), a wider backfat:loin spread(42.5 mm vs 37.6 mm) and earning higher quality premiums ($4.83 vs $4.07). These gender effects are all within the expected range. The thicker loin on the low protein diet was unexpected and needs to be repeated to see if this effect is real.

Detailed results of this experiment can be obtained by requesting Monograph No. 02-03 from the Prairie Swine Centre.

Implications

When diets are formulated on a net energy basis, synthetic amino acids used judiciously, and dietary electrolyte balance is maintained reasonably constant, crude protein levels can be reduced and performance maintained. Indeed, as evidenced by the thicker loin eye on the low protein diet, carcass quality may be improved.

Acknowledgements

Funding for this project from Ajinomoto Heartland Inc., Chicago, IL is gratefully acknowledged. Strategic program funding provided to the Prairie Swine Centre by Sask Pork, Alberta Pork, the Manitoba Pork Council, and the Saskatchewan Agriculture Development Fund.

Table 2. Effects of protein level on pig performance.

	TREATMENT									
	Male			***Female***			***P-values***			
	High	Medium	Low	High	Medium	Low	SEM	Gender	Trt	Gender *Trt
Phase I (30-60 kg)										
Ave. Daily Gain, kg.	0.94	0.92	0.96	0.93	0.91	0.91	0.01	0.14	0.44	0.41
Ave. Daily Feed, kg.	2.05	2.01	2.10	2.03	1.97	2.03	0.02	0.12	0.10	0.75
Gain:Feed	0.46	0.46	0.46	0.46	0.46	0.45	0.004	0.96	0.9	0.66
Phase II (60-90 kg)										
Ave. Daily Gain, kg.	0.95	0.95	0.96	0.93	0.92	0.93	0.01	0.10	0.74	0.98
Ave. Daily Feed, kg.	2.87	2.81	2.92	2.75	2.56	2.62	0.03	<0.001	0.09	0.18
Gain:Feed	0.33	0.34	0.33	0.34	0.36	0.36	0.004	<0.001	0.07	0.17
Phase III										
Ave. Daily Gain, kg.	1.04	1.06	1.03	1.02	1.02	1.02	0.02	0.56	0.93	0.93
Ave. Daily Feed, kg.	3.65	3.54	3.58	3.17	3.24	3.26	0.06	<0.001	0.96	0.66
Gain:Feed	0.29	0.30	0.29	0.32	0.31	0.33	0.006	0.01	0.88	0.40

Table 3. Effects of protein level and gender on carcass parameters.

	TREATMENT									
	Male			***Female***			***P-values***			
	High	Medium	Low	High	Medium	Low	SEM	Gender	Trt	Gender *Trt
Settlement weight, kg	88.60	88.70	88.70	89.54	88.84	89.50	0.23	0.29	0.87	0.83
Index	109.4	109.4	110.2	112.0	112.2	111.6	0.2	<0.001	0.93	0.40
Lean yield, %	59.22	59.00	59.32	60.36	60.54	60.24	0.12	<0.001	0.99	0.30
Value, $	106.5	105.76	109.50	109.58	108.35	109.15	0.73	0.76	0.95	0.97
Fat, mm	21.2	21.7	21.4	19.1	18.4	19.7	0.2	<0.001	0.49	0.23
Lean, mm	58.1	58.6	60.4	61.6	60.0	63.1	0.2	<0.001	0.01	0.31
Spread, mm	36.9	37.0	39.0	42.5	41.7	43.3	0.3	<0.001	0.20	0.81
Price, $	1.10	1.084	1.117	1.091	1.084	1.09	0.07	0.82	0.96	0.97
Premium, $	4.10	3.95	4.17	4.74	4.76	5.00	0.13	<0.001	0.61	0.91
Total carcass value, $	110.6	109.71	113.67	114.32	113.11	114.15				
Total feed cost[1]	51.83	50.56	51.24	49.54	48.20	47.04				
Return/feed costs	2.13	2.17	2.22	2.31	2.35	2.43				

[1]Based on February, 2003 prices.

The Methionine Requirement of Pigs From 25 to 50 kg

John Patience, Denise Beaulieu, Ruurd Zijlstra, Doug Gillis, and Meike Rademacher [1]

Summary

In Western Canada, many protein sources such as peas and lentils which are lower in methionine (total methonine, tMet) than traditional protein sources are being used with greater frequency and in greater amounts. To ensure these diets are properly balanced, an experiment was conducted to establish the methionine requirement for 25 - 50 kg pigs. The requirement for female pigs was 0.25% of the diet and was slightly higher for barrows, at 0.29%. Ileal digestibility of methionine (d met) was 83%. The tMET requirement as a percent of lysine was 23% in females and 27% in males.

Introduction

Methionine is not a limiting amino acid in most commercial swine diets in North America. Thus, it has not been studied as intensively as other amino acids such as lysine, threonine and tryptophan. However, since certain popular ingredients, such as field peas and lentils, are poor sources of sulphur-amino acids (SAA), and since these ingredients are being used with greater frequency and in greater quantities, nutritionists need information on these amino acids to formulate practical diets

Experimental Procedures

Six diets were formulated, containing incremental levels of methionine. The basal diet was formulated to contain 0.19% tMET (0.16% dMET) and 0.36% TSAA (0.28% dSAA). Cystine represented 50% of TSAA in the basal diet.

A total of 150 gilts and 150 barrows were housed in fully slatted concrete floored pens measuring 3.96 m^2 per pig for 28 day growth trials. All pigs were scanned using real-time ultrasound on day 28. Ileal digestibility of the amino acids in the diets was measured in six barrows (75 ± 4 kg) in a related study. Estimates of methionine requirements were computed using orthogonal polynomials.

Results

The experiment was designed with five blocks. However, because feed consumption was greater than anticipated, blocks 4 and 5 were terminated after 14 days.

The gilts' growth response to increased methionine was both linear ($P < 0.03$) and quadratic ($P < 0.04$). Conversely, the response of barrows was neither ($P > 0.05$). The ADG of the barrows averaged 930 g/day, 500 g/day greater than the ADG for female pigs ($P < 0.01$, gender).

The effect of methionine on feed intake followed a pattern similar to the average daily gain. The overall response in feed intake to dietary methionine showed that gender ($P = 0.08$), but not diet ($P = 0.12$), tended to influence the response.

Feed efficiency (gain:feed; G:F) improved in barrows as methionine increased from 0.18% of the diet, to about 0.31% of the diet. In gilts, feed efficiency responded in neither a quadratic nor a linear fashion as the level of methionine increased.

Methionine concentration in the diet affected lean ($P < 0.01$), but not backfat ($P = 0.40$) thickness. The thickness of backfat in gilts tended to respond in a linear ($P = 0.08$) and a quadratic ($P = 0.06$) fashion as the level of methionine in the diet increased.

It is not unusual in studies on amino acid requirements to obtain different results between different genders and using different response criteria.

Apparent ileal digestibility of crude protein and methionine was 83.8% and 83.0% respectively. The apparent digestibility of the other amino acids ranged from 73% for lysine to 92% for glycine. The digestibility of lysine was lower than expected, but was double-checked and the initial results confirmed.

Table 2 summarizes the methionine requirement calculated from variables which responded (or tended to respond) in a quadratic fashion with increased dietary methionine. The tMET requirement for females was found to be 0.25%, but ranged from 0.23 to 0.28% of the diet, depending on the criteria employed. This was equivalent to 4.7 g/d, with a range from 4.4 to 5.4 g/d. The tMET requirement for barrows, is about 0.29% of the diet, or 4.9 g/d. The diets contained 3.45 Mcal DE/kg. Therefore, the tMET requirement can also be expressed as 0.73 g/Mcal DE, with a range from 0.67 to 0.81. Based on protein gain, these pigs require 34.7 mg tMET per gram of protein gain, with a range from 32.9 to 39.1 mg. Our data indicates that female pigs within this weight range require 23% tMET as percent of lysine, with a range from 21.5 to 26.2%. The comparable requirement for barrows is 27% tMET/lysine.

Methionine can be lacking in diets containing pulse crops like peas and lentils.

Implications

The methionine requirement has been defined for 25 to 50 kg pigs. Information on methionine requirements is most critical in pigs fed diets containing field peas, lentils, or other pulse crops known to have low levels of this amino acid.

Acknowledgements

Specific funding for this project was provided by Degussa Corp.

[1] Degussa AG, Rodenbacher Chaussee 4, Box 1345, D-63403, Hannu Wolfgang, Germany

Table 1. The effect of methionine on the average daily gain of weaned pigs. (d 0 - 28).

	Methionine (% of diet)							P-values	
	0.18	0.22	0.25	0.28	0.31	0.32	SEM	Linear	Quad
				Barrows					
ADG (kg/d)	0.80	0.89	0.96	0.92	1.04	0.97	0.03	0.15	0.28
ADFI (kg/d)	1.78	1.87	1.93	1.86	2.03	1.96	0.04	0.59	0.82
G:F	0.45	0.48	0.50	0.50	0.51	0.50	0.01	0.03	0.06
Backfat (mm)[a]	10.6	12.0	11.7	11.7	13.1	12.7	0.74	0.78	0.91
Lean (mm)[a]	35.14	37.67	37.56	37.53	39.57	40.30	0.95	0.89	0.84
				Gilts					
ADG (kg/d)	0.83	0.84	0.94	0.91	0.86	0.87	0.02	0.03	0.04
ADFI (kg/d)	1.87	1.81	1.94	1.94	1.73	1.75	0.05	0.08	0.06
G:F	0.45	0.47	0.48	0.47	0.49	0.50	0.01	0.12	0.27
Backfat (mm)[a]	11.5	11.9	12.7	12.4	9.8	11.4	0.44	0.08	0.06
Lean (mm)[a]	37.54	37.97	39.41	39.71	39.61	39.63	0.66	0.28	0.41

[a]*Determined on d 28*

P values	ADG	ADFI	G:F	Backfat	Lean
Diet	<0.001	0.12	<0.001	0.40	0.007
Gender	0.01	0.08	0.03	0.43	0.15
Gender*diet	0.01	0.001	0.65	0.02	0.37

Table 2. The methionine requirement of weaned pigs calculated using different response criteria and reported as proportions of the diet or other nutrients, and grams per day.

Response factor	*Phase*	tMET (% of diet)[a]	tMET (g/d)[b]	tMET/DE (g/Mcal)	tMET/ g protein gain (mg/g)[c]	tMET/tSAA (x 100)	tMET/LYS (x 100)
				Gilts			
ADG	d0 - 14	0.26	4.37	0.75	32.9	56.9	24.0
ADG	d14-28	0.27	5.40	0.78	39.1	58.9	25.1
ADG	d0-28	0.26	4.78	0.75	35.1	56.9	24.0
ADFI	d14-28	0.24	4.80	0.70	34.8	54.5	22.2
ADFI	d0-28	0.24	4.42	0.70	32.5	54.5	22.2
Gain:feed	d0-14	0.28	4.70	0.81	35.3	59.6	26.2
Backfat	d28	0.24	4.80	0.70	34.8	54.5	22.2
Urea	d28	0.23	4.60	0.67	33.3	53.5	21.5
				Barrows			
Gain/feed	d0-14	0.29	4.90	0.84	35.5	60.4	27.1

[a] Calculated from regression analysis.
[b] Calculated using ADFI data.
[c] Calculated assuming 15.5 % of gain is protein.
[d] Calculated from the TSAA content of the diet and the TMET requirement determined from the regression analysis.
[e] Calculated from the lysine content of the diet and the TMET requirement determined from the regression analysis.

Comparison of Urination Frequency of Grower-Finisher Pigs to Ammonia Emission

Stéphane Lemay, Erin Welford [1], Lloyd Zyla [2], Harold Gonyou, Liliane Chenard, Stéphane Godbout [3], and Ernest Barber [4]

Summary

A computer model can predict ammonia emissions if the number of urine puddles in a room is known. Seventy-two pigs were observed for 26 h at three different times during their grow-finish phase. Urination frequency was similar for males and females and did not change with age. The maximum number of events was between 12h00 and 20h00. Early morning events were rare. Emissions from the room cannot be directly linked to the urination pattern at this point, as puddles will emit ammonia for many hours.

Introduction

Ammonia is a well-known nuisance compound and is the product of urea breakdown in urine puddles and slurry. Therefore, number and location of urine puddles in a grower-finisher room with partially slatted floor is related to ammonia concentration in the room. If the number of puddles is known, it will be possible to calculate how much ammonia is being emitted over a 24-hr period. In agreement with the literature, the contribution of faeces to ammonia emissions is negligible.

The objective of this experiment was to determine the number of urinations per pig per hour to quantify the number of puddles on the floor.

Experimental Procedures

Behaviour measurements were taken during one growth cycle of grower-finisher pigs. One room with six pens (12 pigs per pen) was observed on three occasions at an average pig weight of 50, 64 and 77 kg. There were three pens of females and three pens of males. Each pen was observed for eight minutes each hour, for 26 hr total (10h00 to 12h00 the following day). Observers sitting outside the pen recorded the number of urinations and defecations per pen. Lighting was reduced to 1.6 W/m^2 from 19h00 until 7h00 the following morning, to mimic night conditions with enough light to see activities.

Ammonia concentration in the room was measured periodically during each observation period with an infrared analyser. Ventilation rate was calculated by fan rotational speeds and room static pressure.

Results and Discussion

For females, the maximum number of urinations per pig per hour was 1.3 at approximately 16h00. From 3h00 to 5h00, only one in 10 pigs would urinate in an hour. Similarly, the highest number of male urinations per hour was 1.5 at 11h00. At 4h00 there were no observed urinations by males (Figure 1). The data from males and females were similar enough that it will be possible to combine data to develop an overall pattern of urination frequency. Defecation frequencies were similar to urination frequencies.

Even though larger pigs may excrete more urine, data shows that for the three different average weights, the frequency is the same.

Figure 2 compares urination frequency pattern to ammonia emission for the same period. Between 16h00 in the afternoon and 08h00 the following day, ammonia emissions varied in a range of 4 to 5 mg/s. Over that time, urination frequency oscillated between 2 and 3 Event/h per pig and went down to 0 Event/h per pig for three hours (03h00 to 06h00). Even if no urine was excreted for three hours, room emissions stayed relatively the same. Emission from a puddle can continue for many hours, so further investigation into the emission pattern from a single puddle may help explain why there is little variation in ammonia emission when there is a greater variation in urination frequency.

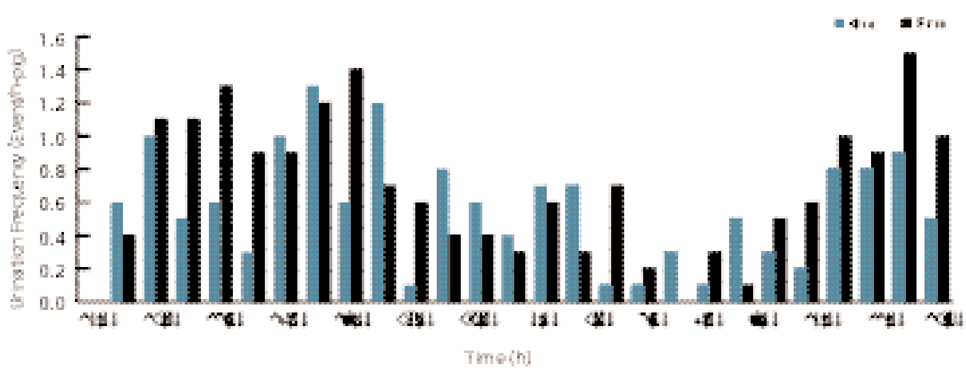

Figure 1: Average urination frequency for males and females.

Implications

By monitoring and observing the urination frequency of grower finisher pigs, it will be possible to develop a curve to predict the number of urinations by a pig on an hourly basis. This will be important when trying to predict ammonia emission from a room since the urine puddles on the floor contribute significantly to the overall ammonia production in a room. Since there is no direct correlation between the number of urinations and the ammonia emission, further investigations into the release of ammonia from individual puddles over time will be required in order to predict the ammonia emissions to the environment, based on the number of pigs and their urination frequency.

Acknowledgements

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Project funding provided by Natural Sciences and Engineering Research Council of Canada (NSERC).

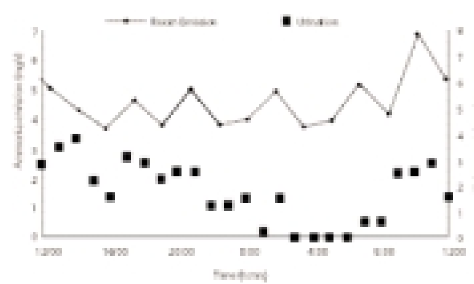

***Figure 2:** Room ammonia emissions and urination frequency from October 18th to 19th, 2001.*

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The Net Energy System and Diet Formulation: An Overview

A. Denise Beaulieu, John Patience, and Temi Oresanya

Introduction

Energy is available to an animal following the breakdown of ingested feed. The energy is released as heat, or used for metabolic processes such as maintenance, growth or production. During the conversion of a feedstuff to useful energy, several losses occur (Figure 1). Typically, only about 50 to 60% of the total energy in common feed ingredients is actually available for use by the pig. The rest is lost due to incomplete digestion, the excretion of gases, and an inevitable loss of heat that occurs during normal metabolism.

Gross energy is the energy released following combustion of a feed sample. It provides little useful information about the value of this energy because it fails to account for that portion of energy that is unavailable to the pig. Digestible energy (DE) is that proportion of gross energy not lost in faeces. The metabolizable energy (ME) is the amount of DE not lost in the urine or as gas. Not all the ME is available to the animal for growth or production. A portion of the energy is lost as heat (heat increment, HI) associated with the normal processes of digestion and nutrient metabolism.

Net energy, the efficiency of use of ME, is therefore defined as energy retained in the body or as the ME minus the energy lost as heat. The NE is usually divided into energy for maintenance (NEm) and retained energy (RE) or the energy used for growth (NEg). Heat production is essential, but decreases the energy available for productive purposes and should be minimized. The NE system is superior to ME because the HI and the metabolic utilization of ME varies according to the diet chemical characteristics and the physiological state of the animal. We will now describe these in greater detail.

Factors Influencing Net Energy

Animal Factors

Genotype. The efficiency of use of ME depends upon the protein:lipid deposition ratio. Pigs with a high lean growth rate potential respond to higher energy intakes by increasing lean rather than fat deposition. Increasingly, we are learning that a significant breed effect exists for the use of ME for maintenance. For example, in some breeds, the weight of the intestinal tract is higher, as a percentage of total body weight, than in other breeds. The amount of energy required for maintenance is believed to be closely related to the relative weight of the intestinal tract.

Physiological state

Figure 2 illustrates the portion of energy that is lost or used for various purposes by a growing sow or a sow at maintenance.

Maintenance. Maintenance is arbitrarily defined as the energy required to maintain body functions plus moderate activity in a thermoneutral environment. Although the net energy required for maintenance is higher than for growth, most net energy systems combine these two requirements into one number.

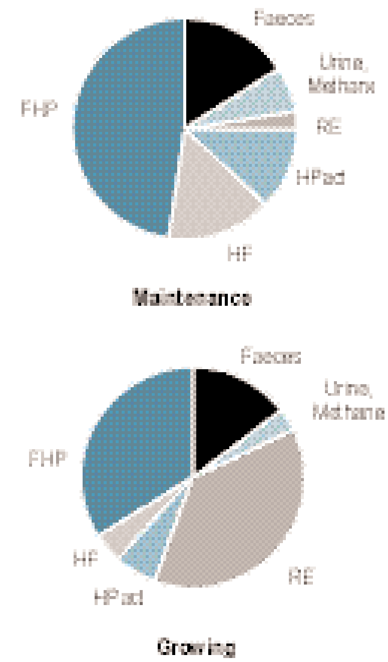

Figure 2: *The partitioning of gross energy in 200 kg sows at maintenance and growing pigs.*

Activity. Physical activity is an important contributor to energy requirements. Heat production associated with standing in sows (HPact: Heat Production for activity) was estimated to be four times greater than in other species. In individually reared or group housed young pigs, the HPact accounted for 47 or 59 kcal per day /kg $BW^{.60}$ respectively, or about 15 % of their total heat production.

Growth. Unlike the net energy used for maintenance (NEm) which is a non-productive use of energy, the producer is interested in the net energy used for gain, (NEg) which includes the energy required for growth – and the accompanying protein and lipid deposition – reproduction, lactation and work. There are various estimates in the literature of the energy cost per gram of protein or lipid deposited. The energy cost of protein deposition ranges from 7 to 15 Mcal ME/kg and the estimates for fat deposition range from 12 to 16 Mcal ME/kg. Interestingly, the energy required to deposit a gram of protein is not much different than that

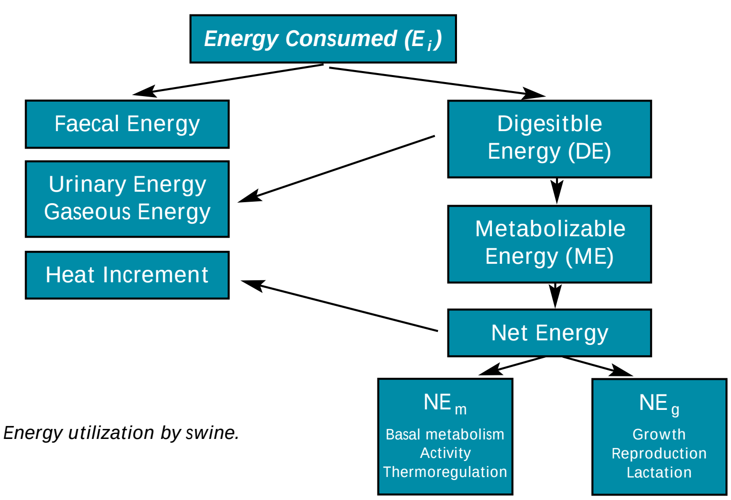

Figure 1: *Energy utilization by swine.*

required to deposit a gram of fat. However, since protein deposition is also associated with a substantial amount of water, and lipid has little associated water, "lean" gain is more efficient than "fat" gain.

Pregnancy and Lactation. Weight gain during gestation is required for growth of the reproductive tissues, storage of body reserves and possibly growth of the gilt or sow to mature size. Because the composition of this gain changes as pregnancy advances, the use of ME during pregnancy also changes. More than 75% of the energy intake by pregnant sows is needed to meet the maintenance requirement. The efficiency of use of ME for milk synthesis is about 0.71, regardless of whether the energy is derived from the diet or body reserves.

Dietary Factors

The heat increment of animals on different diets with the same DE or ME is not constant, and thus the NE varies between diets. Table 1 demonstrates how the rankings of feed will vary depending on the energy system used. It is clear from this table that DE and ME tend to overestimate the true value of ingredients high in protein (eg. soybean meal), and tend to underestimate the value of ingredients low in protein (eg. barley).

Fibre. The efficiency of use of ME for NE is low when the ME comes from crude fibre. The chemical constituents of fibre that negatively affect NE are poorly understood.

Protein. High dietary CP is associated with an increased energy demand required for the deamination of excess amino acids, for the synthesis and excretion of urea and urine, for protein turnover, etc. Growing pigs fed a 17.8% CP diet required 100 kcal more ME per day to obtain similar energy retention to pigs fed a 15% CP diet. When diets are formulated on an equal ME basis, lower CP results in higher energy gain as fat due to increased NE of the low CP diet (Table 2). This is one of the key reasons why net energy is considered a superior system for diet formulation. Indeed, in Europe, the NE system has become the industry standard.

Practical Application of the NE System

The useof ME for NE is affected by the chemical composition of a diet and the use of nutrients for productive purposes. Research evaluating the NE values of feedstuffs is extremely expensive and time-consuming since the NE value of a feed depends on both the nutrient composition and the productive function of the pig. Prediction equations must be validated with several groups of animals at different stages of production. It is therefore a more complex system to implement than DE or ME. The NRC (1998) has included estimates of the NE content of feedstuffs, but requirements are based on DE or ME.

The following equation developed by Noblet in France (1994), has been widely cited as a way of estimating the net energy content of common ingredients :

NE (kcal/kg DM) = 0.703 x DE + 1.58 x EE + 0.47 x ST – 0.97 x CP – 0.98 x CF where DE is in kcal/kg DM and chemical characteristics are in g/kg DM.

Conclusions

The NE system of evaluating the energy content of the diet considers the metabolic use of nutrients and is thus the "preferred" energy system for formulating diets. Although the above statement has been recognized for decades, the NE system is only slowly being implemented for use in practical diet formulation for swine in North America. As more information becomes available on the NE content of common ingredients, and as we learn more about how animals use dietary energy under practical conditions, the NE system will become much more common.

Net energy, a superior system for diet formulation, is becoming the industry standard in Europe, but is still being evaluated for use in North America.

Acknowledgements

Strategic program funding provided by Sask Pork, Alberta Pork, the Manitoba Pork Council and the Saskatchewan Agriculture and Food Development Fund.

Table 1. A comparison of the rankings of feed by energy system. Wheat has been arbitrarily assigned a value of 100 (based on NRC 1998)

Feed stuff	DE	ME	NE
Wheat	100	100	100
Corn	104	101	115
Barley	90	86	111
Soybean meal	103	94	93
Canola meal	85	78	78
Animal fat	210	202	211
Canola oil	230	221	230

Table 2. The NE content of high and low CP diets formulated with different ingredients (PSC 2002)

Ingredients [a](%)	High CP	Low CP
Wheat	60.4	33.3
Soybean meal	24.2	19.9
Barley	11.2	40.3
Canola oil	1.0	3.0
Crude Protein	21.0	18.6
Starch	48.0	46.3
Ether extract	2.72	4.64
Crude Fiber	3.07	3.67
DE	14.23	14.23
ME	13.3	13.4
NE	10.15	10.32
NE/DE	0.71	0.73

Can We Alter Water Utilization in Growing Pigs by Diet Manipulation?

Marnie Shaw, John Patience, A. Denise Beaulieu, and James Usry [1]

Summary

Concerns relating to the use of water resources by the livestock industry, combined with the rising cost of manure management, have resulted in greater interest in defining more precisely the water consumption of pigs. A study was conducted to determine if the crude protein or mineral content of a diet affected water consumption by growing pigs. Although water use was increased when the crude protein or mineral content of the diet was excessive, factors other than the diet appear to have a greater impact on water use by the pig.

Introduction

Limited information is available on the impact of diet composition on voluntary water intake in swine. In Canada, water has traditionally been abundant and inexpensive. However, present concerns relating to the use of water by the livestock industry, combined with the rising cost of manure management, have resulted in greater interest in more precisely defining the water needs of pigs.

Experimental Procedures

A total of 48 barrows (70.2 ± 2 d, 34.3 ± 4.6 kg BW) were housed in individual metabolism pens. A low CP diet, supplemented with lysine, methionine, threonine and tryptophan was compared to a high and to an excessive CP diet. The excess CP diet was formulated to support growth that was 25% above expected. A fourth diet contained excess calcium, phosphorus, and salt (Table 1). Daily water intake (ADWI) and spillage were determined daily using individual water meters connected to bowl drinkers. Faeces and urine were collected on days 11 to 14 of each period to allow us to accurately determine water intake, water output and the water:feed ratio. Water intake included not only drinking water, but also water contained in the feed and water produced by normal metabolic processes. Water output included faeces, urine and water retained as a consequence of growth. Water exhaled from the lungs was not measured.

Results and Discussion

On average, drinking water represented 83% of total water intake; feed and metabolic water represented 3% and 14% of the total, respectively. Of the measured water outputs, growth constituted only 8% of the total, while faeces represented not much more at 9%. Urine output represented 83% of the measured total. If we assume that the unmeasured water balance – the difference between intake and measured output - was primarily water lost through respiration, this would have constituted 49% of the total. Urine would then have represented only 42% of the total daily water balance.

Diet may affect water use by pigs, but environment and water delivery systems have a greater impact.

The ADWI (P=0.06) and water output (P=0.06) tended to increase when pigs received the excess CP diet (ExCP; Table 2). Additionally the water:feed ratio increased when pigs consumed this diet (P=0.01; Table 2). Pigs that consumed the excess mineral diet (ExMin) had increased output of water in faeces (P=0.02; Table 2).

An attempt was made to develop equations to predict water intake of growing pigs from the diet composition or intake of specific nutrients. A prediction equation containing daily intake of feed nitrogen, calcium, phosphorus, sodium, potassium and chloride as independent variables resulted in the highest R^2. It was, however, only able to explain 33% of the variability in water intake. In all cases, the ability to detect treatment differences was hampered by the large variability among individual pigs for water intake and output. The pigs were housed individually in this experiment; however, it had been shown in previous experiments when the pigs were housed in groups that a lack of social interaction was not the cause of this variability.

Implications

Feeding a diet containing excessive dietary protein will result in increased water use by growing pigs. This makes sense as additional water will be needed to remove the by-products of protein breakdown from the body. Surprisingly, reducing CP by increasing the use of synthetic amino acids will not reduce water intake. Although diet composition may influence water utilization in growing pigs, other factors, such as the environment and the design of the water delivery system, appear to have a greater impact. The water:feed ratio was confirmed to be in the range of 2.5:1, provided excess nutrients are not present in the diet.

Acknowledgements

Support for this project was provided by the Agriculture and Agri-Food Canada/National Sciences and Engineering Council Research Partnership Program and by Ajinomoto Heartland. Strategic program funding provided to the Prairie Swine Centre by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development.

[1] Ajinomoto Heartland, Chicago, IL, USA.

Table 1. Composition of experimental diets (as fed basis)[1]

	Low CP	HiCP	ExCP	ExMin
Ingredient, %				
Wheat	64.6	40.2	30.0	38.9
Barley	20.0	30.6	25.2	29.6
Soybean meal	10.8	25.3	40.9	24.6
Canola oil	1.0	1.0	1.0	2.0
Dicalcium phosphate	0.5	0.5	0.5	1.7
Limestone	0.8	0.7	0.6	1.2
Salt	0.4	0.4	0.4	0.9
Nutrients				
DE, Mcal/kg	3.33	3.32	3.37	3.31
gDLys/Mcal DE	2.42	2.42	3.40	2.41
Crude protein, % DM	17.8	21.4	25.4	20.4
Calcium, % DM	0.57	0.51	0.58	1.00
T Phosphorus, % DM	0.47	0.51	0.54	0.76
Sodium, % DM	0.25	0.14	0.16	0.36
Chloride, % DM	0.44	0.28	0.33	0.70
Potassium, % DM	0.55	0.81	0.99	0.76
Electrolyte balance (dEB)	126	178	235	154

[1] All diets contained mineral and vitamin premixes. The Low CP diet also contained $NaHCO_3$, L-Lysine-HCl, DL-Met, L-Thr and L-Try.

Table 2. The effect of dietary protein and mineral content on water balance and performance in growing pigs.

Water Balance, g/d	Low CP	HiCP	ExCP	ExMin	SEM	*P*=
Intake						
Drinking	5500	4952	6265	5489	326	0.06
Feed	194	199	202	201	4	0.62
Metabolic[1]	1002	925	949	937	20	0.05
Total intake	6697	6076	7415	6626	336	0.06
Output						
Faecal	289	286	310	328	10	0.02
Urinary	2839	2492	3417	2608	256	0.07
Growth[2]	266	290	278	278	12	0.57
Total output	3394	3069	4005	3213	252	0.06
Water:feed	2.50	2.46	3.14	2.66	0.15	0.01
Performance, kg						
ADG	0.98	0.89	1.02	1.03	0.04	0.04
ADFI	2.21	2.02	1.99	2.07	0.05	0.01
G:F	0.45	0.44	0.51	0.50	0.02	<0.01

[1] Water produced by metabolism of feed ingredients.

[2] Based on N retention data, calculated as (PDR*2.25)*70/100 (NRC 1998).

Moisture Production of Grower-Finisher Pigs: Field Measurements Compared With Theoretical Values

Shala Christianson [1], Stéphane Lemay, Claude Laguë [2], John Patience, and Ernest Barber [3]

Summary

Moisture levels in intensive swine operations (ISOs) are a concern in cold climates, as excess moisture may lead to condensation and bacterial growth inside the rooms. The moisture production (MP) of two grower-finisher rooms were measured and compared to predicted values to determine the validity of moisture production equations currently used for design purposes. The CIGR (1984) equations provided the best average MP values, with an 8% difference, and for all the prediction equations used in this study, diurnal MP patterns were not predicted. Further research needs to be done to update the MP equations and to provide engineers with appropriate values for designing ventilation systems.

Introduction

When the engineer designs ventilation systems for an ISO, the MP within the room is used to select the minimum ventilation rate to control for humidity in cold conditions. Over-ventilation would increase heating costs in winter conditions, and under-ventilation would foster undesirable high humidity levels in the room. The objective of this study was to verify that the MP equations currently used in designing ventilation systems for an ISO are suitable for Canadian climates, which would help ensure the optimal minimum ventilation rate is chosen.

Experimental Procedures

The MP of four grower-finisher cycles was measured on 15-min intervals, and the measurements were compared with predicted values. The predicted values were determined using equations provided by the International Commission of Agricultural Engineering (CIGR), which has two sets of MP equations (CIGR 1984, CIGR 2002) and from the American Society of Agricultural Engineers (ASAE 2002) handbook, which is based on equations provided by Bond et al. (1959).

Results and Discussion

Figure 1 presents a summary of the average MP over three different weight ranges in g water/15 min-kg. The MP equations from CIGR (1984) yielded the best estimates for MP, but underestimated the average MP by 8% for all cycles. The MP equations provided by CIGR (2002) and Bond et al. (1959) also underestimated the average MP by 13 and 31%, respectively. As shown in Figure 2, diurnal MP patterns were not predicted by the MP equations used in this study, and the maximum daily MP was underestimated by as much as 56%. These equations are not suitable for dynamic modeling of MP.

Implications

If the current MP is actually higher than predicted in swine barns, the minimum ventilation rate to control the humidity level of the room needs to be higher than the current design criteria. If the minimum ventilation rate increases, the current heater capacity may not be sufficient to compensate for the additional heat loss in cold conditions. The CIGR (1984) equations may be used to predict average MP values for design purposes, but additional work needs to be done to update the MP equations to better reflect the actual MP conditions in swine grower-finisher rooms. This will help to ensure the engineer selects the proper minimum ventilation rate design for the ISO.

Acknowledgements

Strategic program funding program provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by the Natural Sciences and Engineering Research Council of Canada.

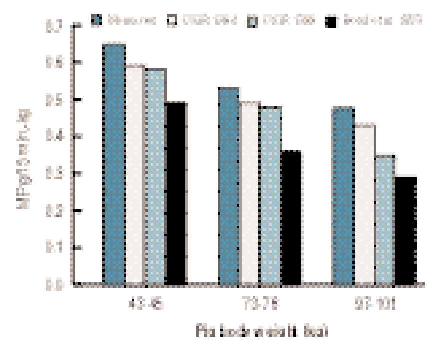

Figure 1: *Comparison of average moisture production (MP) in g/15 min·kg values for pigs on dry feeders: current study, CIGR (1984), CIGR (2002), and Bond et al. (1959) for three different weight ranges.*

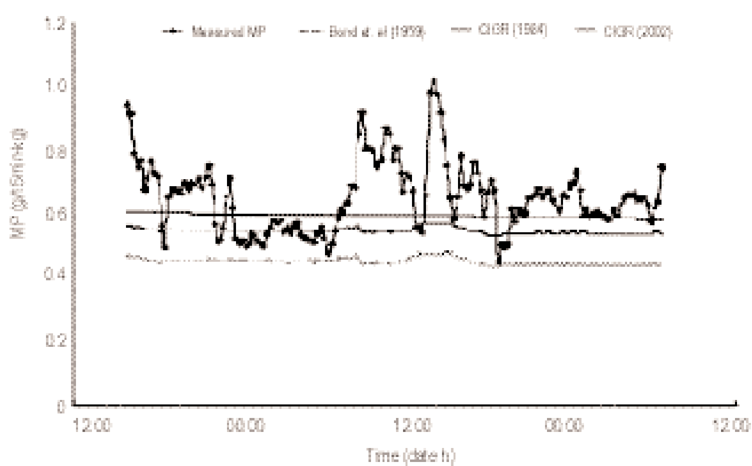

Figure 2: *Measured moisture production (MP) and calculated MP for grower pigs (43-45 kg) on dry feeders in the second experiment in g/15 min^{-1}/kg^{-1}.*

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[3] Dean, College of Agriculture, University of Saskatchewan

Effect of Dietary Crude Protein Cotent and Phase Feeding on Performance and Urinary Nitrogen Excretion of Grower Pigs

Nicole Rodgers [1] and Ruurd Zijlstra

Summary

Nitrogen excretion is of concern because of its potential impact on the environment inside and outside the barn. Urinary nitrogen excretion can be reduced using dietary manipulations. Results indicate that a 2% reduction of dietary protein content throughout the grower phase reduced urinary nitrogen excretion by 22% without affecting performance. Phase feeding did not affect urinary nitrogen excretion or performance.

Urinary nitrogen excretion can be reduced more effectively by reducing dietary protein content than by using phase feeding.

Introduction

Urinary nitrogen is emitted easily as ammonia while faecal nitrogen is less volatile because it is bound within proteins. Reduction of dietary protein while balancing for amino acids is a direct way to reduce urinary nitrogen excretion and ammonia emission. Phase feeding might allow a better dietary matching of the rapidly changing amino acid requirements of grower pigs and thereby further reduce the urinary excretion of excess dietary nitrogen.

Experimental Procedures

Two levels of dietary crude protein (high, avg. 19%; low, avg. 17%; ideal amino acid profile 3,400 kcal DE/kg) and three different phase feeding programs (2 diets for 3 week each, 3 diets for 2 week each, and 6 diets for 1 week each; Figure 1) were used as six treatments in a 2 x 3 factorial arrangement with 27.5-kg barrows. In a performance study, pigs were housed five pigs/pen with free access to feed. In a metabolism study, pigs were housed in individual pens; faeces and urine were collected.

Results and Discussion

In the 6-week performance study, average daily gain (ADG; Figure 2) and average daily feed intake did not differ between the high and low crude protein level or among the three phase feeding programs. For successful implementation of dietary strategies to reduce nitrogen excretion, growth performance should not be reduced. For the entire six-week metabolism study, urinary nitrogen excretion was reduced 22% by feeding low instead of high protein diets (Figure 3) but did not differ among the three phase feeding programs. Faecal nitrogen excretion did not differ among the dietary treatments.

Implications

Lower total nitrogen excretion may reduce land base needed to apply manure in a sustainable manner. Lower urinary nitrogen excretion will reduce ammonia emission inside and outside the barn. The cost for implementing low protein diets will greatly depend on fluctuating ingredient prices. For example at the present time for diets with an optimized digestible nutrient content, a 2% reduction in dietary crude protein increases the cost by $ 5 to 10 per tonne.

Acknowledgements

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council, and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by NSERC and AAFC.

	1	2	3	4	5	6
2 Phases	Diet 2 2.8			Diet 5 2.2		
3 Phases	Diet 1 3.0		Diet 3 2.6		Diet 5 2.2	
6 Phases	Diet 1 3.0	Diet 2 2.8	Diet 3 2.6	Diet 4 2.4	Diet 5 2.2	Diet 6 2.0

week of experiment

***Figure 1:** The three phase feeding programs with lysine values in g dig. lysine per Mcal DE. Diet 1 contained 21.5 (high) or 19.5% (low) crude protein in 1% increments down to 16.5 (high) or 14.5% (low) crude protein for Diet 6.*

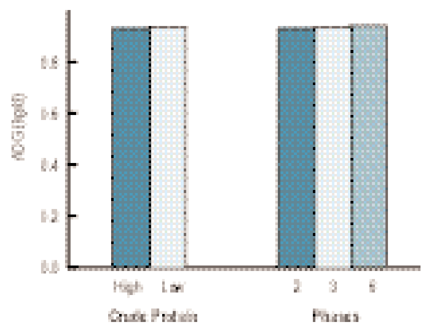

***Figure 2:** Effects of dietary crude protein and phase feeding on average daily gain of grower pigs in the 6-week performance study.*

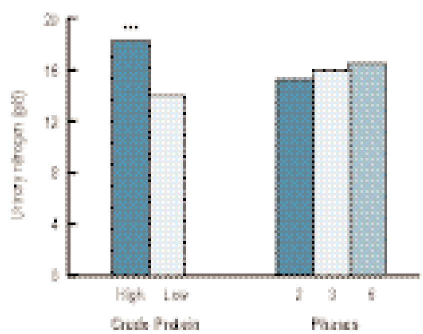

***Figure 3:** Effects of dietary crude protein and phase feeding on urinary nitrogen excretion of grower pigs in the 6-week metabolism study.*

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A Low Protein Diet and Oil Sprinkling to Reduce Ammonia Emissions From Pig Barns

Michel Payeur [1], Stéphane Lemay, Ruurd Zijlstra, Stéphane Godbout [2], Liliane Chénard, Ernest Barber [3], Claude Laguë [4], and Shala Christianson

Summary

Ammonia concentrations in swine barns have an adverse impact on the health and safety of workers and animals. Ammonia also has the potential to cause eutrophication and acidification of water and soil. The impact of raw canola oil sprinkling and a low protein diet with fermentable carbohydrates (FC) on ammonia emissions of grower-finisher rooms was investigated. Ammonia emissions were reduced by 42% with the low protein diet with FC, and oil sprinkling did not affect the ammonia levels. Reducing the protein level and including FC in pig diets is an effective way to decrease ammonia emissions of swine buildings.

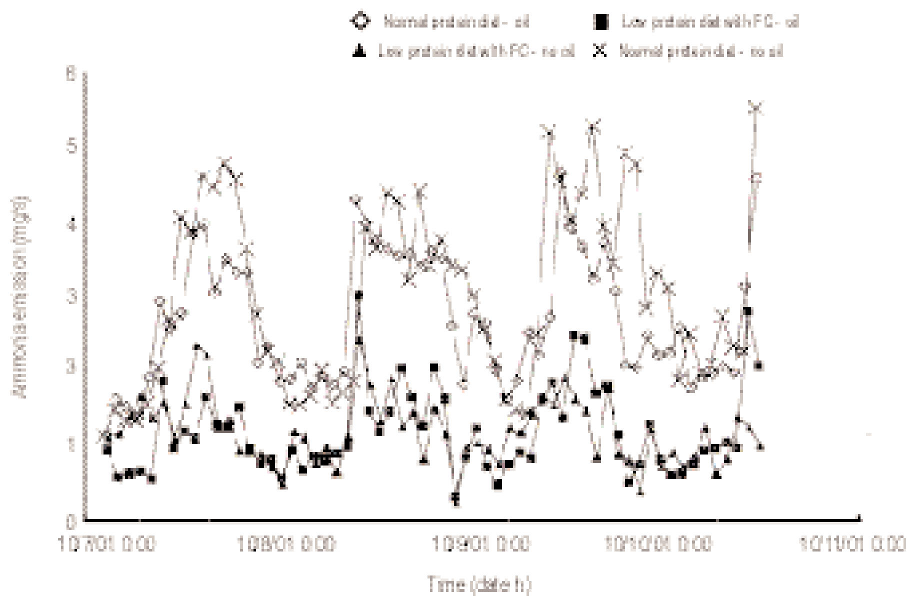

Figure 1: *Ammonia emissions from each room between October 7 and October 10, 2001.*

Low protein diets reduce ammonia emisions, but oil sprinkling has no effect on these emissions.

Introduction

Previous research has shown that reducing dietary protein and inclusion of FC both result in reduction of ammonia emissions. Oil sprinkling in swine barns has also been shown to have varied results on the impact on ammonia emissions. The objective was to perform a full-scale study to investigate the results on ammonia emissions when both a low protein diet with FC and oil sprinkling are used.

Experimental Procedures

Four commercial rooms at PSC were used to measure the impact of the different treatment combinations on ammonia emissions over three grower-finisher cycles. Two raw canola oil application rates (0 and 10 ml/m^2 per day) and two feed formulations (normal protein diet and low protein diet with FC) were investigated. The ammonia emissions and pig performance were monitored.

Results and Discussion

Figure 1 presents typical results of the ammonia emissions from the four rooms. Ammonia emissions were reduced by 42% over the three cycles ($p<0.05$) using the low protein diet with FC. The oil application did not have any impact on ammonia emissions ($p>0.05$), and pig performance was not affected by the treatments ($p>0.05$).

Implications

Sprinkling canola oil in the room does not significantly impact ammonia emissions from swine buildings, but ammonia emissions do decrease when both the protein level is reduced and FC is included in pig diets.

Acknowledgements

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by the Canadian Pork Council and Agriculture and Agri-Food Canada through the HEMS and the LEI programs.

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Airborne Dust, Endotoxin and DNA Downwind From Swine Barns: An Update

Jayda Cleave [1], Laura Ingram [2], Ernest Barber [3], Philip Willson [1]

Introduction

The intensive livestock industry is under continuous scrutiny in relation to potential environmental impacts and health safety issues. Adverse health affects due to dust exposure from intensive livestock facilities have received increasing attention and today are a major concern. There is reason to believe that endotoxins and microbial DNA are present in dust exhausted from swine barns. Endotoxin is a pulmonary irritant contained in the cell wall of Gram-negative bacteria that when inhaled may cause cough, phlegm, wheezing, fever and in severe cases may lead to chronic airway inflammation. In addition, a natural property of the immune system is to respond to the stimulus of microbial DNA. In order to determine the impact of barn aerosols, endotoxin and DNA concentrations must be investigated. Therefore, the objective of this study is to quantify the amount of airborne endotoxin and DNA downwind from a swine facility. It is hypothesized that increased levels of endotoxin and DNA will be detected close to the exhaust fans and that airborne endotoxin and DNA a few hundred meters away will not be different from "fresh air" upwind from the barn.

Adverse health effects due to dust from livestock facilities is a cause for concern.

Experimental Procedures

Project Sites

The project sites were Prairie Swine Centre, Elstow Research Farm Inc. and Big Sky Farms, Rama, SK. Total dust sampling for the determination of airborne endotoxin and DNA commenced in April 2001 and was completed in August 2002.

Air Sampling

A total suspended solids high volume air sampler was used. Three samples were taken at each time point, prior to seeding, during seeding and in mid-summer to incorporate times of high and low dust loading. High volume sampling was performed at 2400m upwind ("fresh air"), 600m downwind from the barn and at an outlet (0.1m). A standard sampling time of 24 hours was used as recommended by Saskatchewan Environment. Total dust was determined by weighing the filters, in triplicate, before and after each sampling event. A weather station that provided continuous data on wind direction, wind speed, air temperature, and relative humidity was established by Dr. Maule to aid in the interpretation of all air samples. Three samples were excluded from analysis (and repeated) due to change in wind direction or other problems.

Post sampling, the dust was then extracted from the filter with sterile nonpyrogenic water during incubation in a sonicator. The extract was analyzed for endotoxin, using a Limulus Amebocyte Lysate test kit, and DNA, using standard UV absorbance techniques.

Statistical Method

A Kruskal-Wallis one-way analysis of variance was used to compare the data. A value of $P<0.05$ was considered statistically significant.

Results and Discussion

Total dust (Figure 1; $P<0.001$) and endotoxin (Figure 2; $P<0.001$) concentrations declined significantly at a distance from the barn. Comparison of mean ranks indicated that at both study sites there was no significant difference between the dust and endotoxin concentrations 600m downwind compared to 2400m upwind but the concentrations at the outlet were significantly higher than the upwind and downwind locations. Location did not have a significant effect on DNA concentrations ($P=0.0733$; Figure 3) around the swine barns. Season did not have an impact on total dust ($P=0.3496$), endotoxin ($P=0.3982$) or DNA ($P=0.8117$) concentrations downwind from swine barns.

The results support the hypothesis that the concentration of total dust and endotoxin 600m downwind from the barns is not statistically different from the "fresh air" upwind from the barn. However, neither distance from the barn nor season had a statistical impact on DNA. Microorganisms are ubiquitous, therefore more detailed research is required to attribute the endotoxin and DNA found in the air downwind from the barns to the swine operation. The data shows that contaminants expelled from the two Saskatchewan swine barns, are diluted to that of background levels 600m downwind from the barn. It may be suggested that airborne contaminants downwind from swine operations are not necessarily a direct result of the swine facility itself, especially in agriculturally active areas. In addition, many environmental factors may have an impact on the distribution of the airborne contaminants. For the purposes of this study it was assumed that the activity within the barn was consistent and would not have an impact on the output of contaminants from the barn. However, the activities within the barn could in fact have an impact on the types of contaminants and the amount of contaminants exiting the barn.

Contaminants expelled from the test barns are diluted to background levels 600m downwind.

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Implications

There appears to be modest environmental impact downwind from barns, which may be managed with controls such as landscaping. These results are applicable to modern confinement livestock operations that interact with neighbours or the general public.

Environmental impact is modest, and can be managed with controls like landscaping.

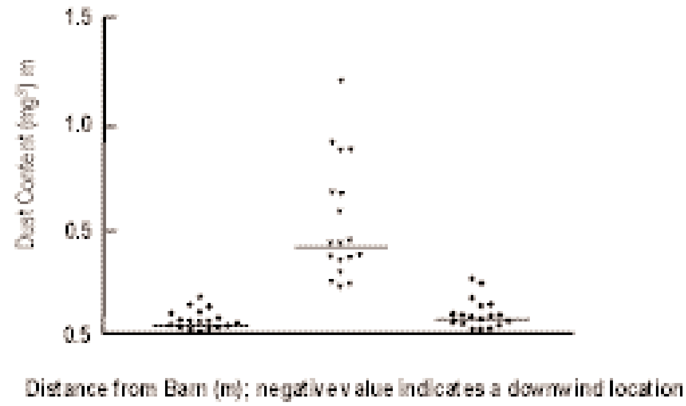

Figure 1: *Total dust concentration (mg/m³) upwind 2400m, at the outlet (0.1m) and 600m downwind from the barns.*

Acknowledgements

Support for this work was provided by the Canadian Institutes of Health Research - PHARE, Canadian Pork Producers Livestock Environmental Initiative, Saskatchewan ADF, Big Sky Farms Inc., Spirit Creek Watershed Monitoring Committee, Sask Pork, Alberta Pork, and Manitoba Pork Council.

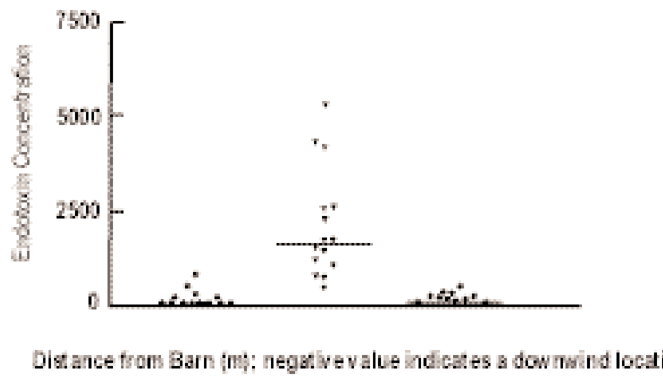

Figure 1: *Endotoxin concentrations (EU/m³) upwind 2400m, at the outlet (0.1m) and 600m downwind from the barns.*

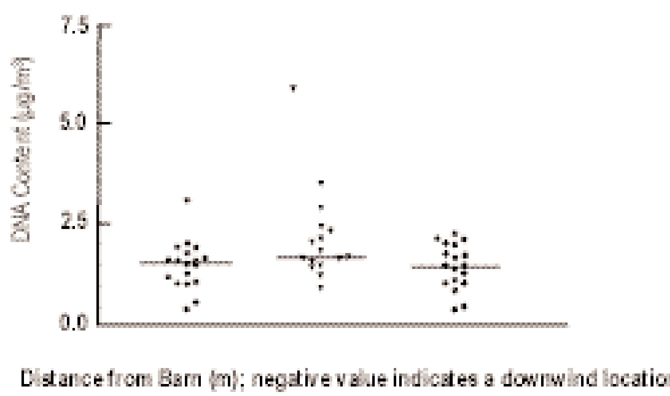

Figure 1: *DNA concentrations (ug/m³) upwind 2400m, at the outlet (0.1m) and 600m downwind from the barns.*

Impact of Combining a Low Protein Diet and Oil Sprinkling on Odour and Dust Emissions of Swine Barns

Michel Payeur [1], Stéphane Lemay, Ruurd Zijlstra, Stéphane Godbout [2], Liliane Chénard, Ernest Barber [3], Claude Laguë [4], and Shala Christianson [1]

Summary

Odours from intensive swine operations are a significant limiting factor in the expansion of the pork industry, and dust in pig housing is suspected to be the cause of work-related respiratory symptoms in pig farmers. The impact of canola oil sprinkling and a low protein diet on dust and odour emissions of grower-finisher rooms was examined. Sprinkling oil reduced total dust emissions by 76% but the effect of oil sprinkling and low protein diets did not have a clear impact on odour emissions. Based on this study, reducing the indoor dust levels does not decrease building odour emissions.

Introduction

A dust control strategy shown to be promising in reducing dust in pig housing is oil sprinkling. Oil sprinkling has also been shown to reduce gas emissions, possibly affecting the odours emitted from the barn. The objective of this study was to investigate the effect of a low protein diet with fermentable carbohydrates (FC) and oil sprinkling on dust and odour emissions of grower-finisher rooms, and to determine the relationship between the two parameters.

Experimental Procedures

Four commercial rooms at PSC were used to measure the impact of the different treatment combinations on dust and odour emissions over three different grower-finisher cycles. Two raw canola oil application rates (0 and 10 mL/m^2 per day) and two feed formulations (normal protein diet and low protein diet with FC) were used. During the experiment, the dust and odour concentrations were monitored in the four rooms.

Results and Discussion

Figure 1 shows the dust emission from the rooms over the experimental cycle. The oil application significantly reduced total dust emissions by 76% ($p<0.05$) and pig performance was not affected by the treatments ($p>0.05$). The experimental diet did not significantly affect dust emissions ($p>0.05$). Figure 2 presents the results from the odour evaluations. Due to high variability of the results for odours, neither the oil sprinkling nor the experimental diet affected odour emissions or the hedonic tone ($p>0.05$). In this experiment, there was no relationship between dust and odour emissions.

Implications

Sprinkling of canola oil was effective at reducing the dust emissions in grower/finisher rooms, but the low protein diet with FC did not reduce dust emissions. The results from the odour measurements were so variable that future research will be done to ensure the odour is characterized in a more effective manner.

Acknowledgements

Strategic project funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by the Canadian Pork Council and Agriculture and Agri-Food Canada through the HEMS and the LEI programs.

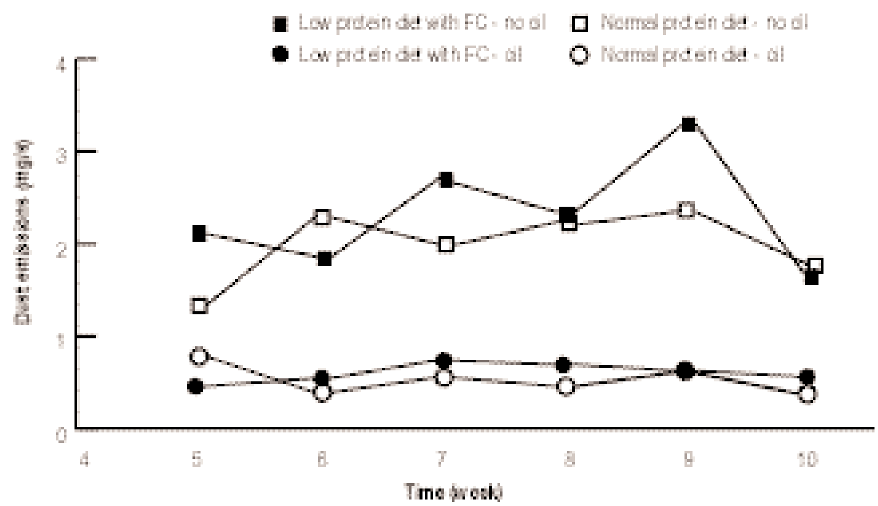

Figure 1: *Evolution of total dust emissions for the different treatment combinations.*

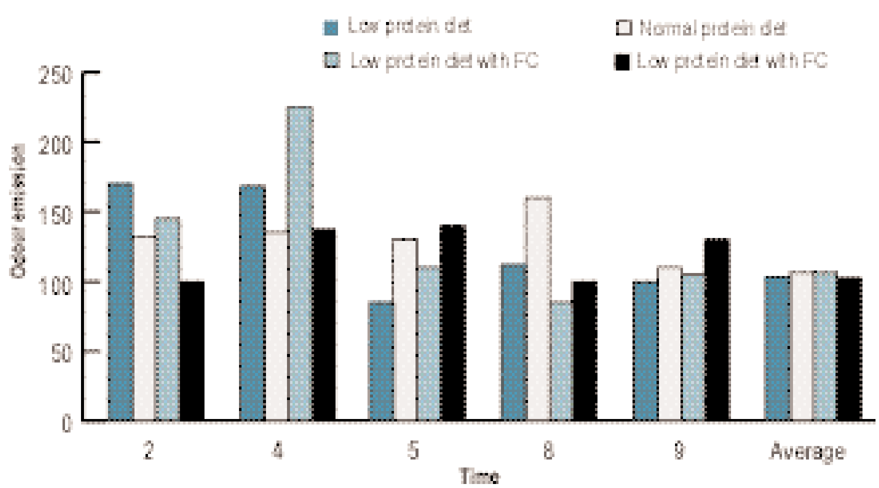

Figure 2: *Odour emissions for the different treatment combinations.*

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