PRAIRIE SWINE CENTRE INC.

Mission Statement

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

The Bottom Line for 2004

Highlights in the 2004 Annual Research Report

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Glossary

ADF - A fibre fraction used to identify characteristics of feed stuffs.

ADFI - Average daily feed intake.

ADG - Average daily gain.

Ad Libitum - Full access to feed or unrestricted feeding.

Aerobic - Process that takes place with oxygen in the environment.

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 cal-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_5 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.

EMB - Earthen manure basin

Endotoxin - Poison produced by certain bacteria and released upon the destruction of the cell.

Glucosinolates - Naturally produced anti-nutritional 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 sulphide. A colourless, poisonous gas that produces a "rotten egg" odour. In pig barns, it is produced by the breakdown of manure.

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 - Lowest portion of the small intestine

K - Potassium

Kcal - Kilocalorie, or one-thousand calories. One calorie is the amount of energy required to raise one gram of water one degree Celsius.

Lysine - An amino acid essential for growth. Cereal grains are generally ppor in lysine.

Nitrate - NO_3 a nitrogen compund found in manure.

N - Nitrogen, a major component of the atmosphere and essential plant nutrient.

NDF - Neutral detergent fibre. One fraction of the total fibre found in a feed stuff.

P - Phosphorus.

Plasma Urea - Urea contained in blood plasma. Urea is the principal end product of nitrogen metabolism in mammals.

Proximate analysis - A testing protocol used to determine the makeup of a food stuff. (ex. fats, proteins)

Psychrometer - An instrument used to measure water vapour 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.

Sonicating - Mixing or homogenizing a liquid using sound waves.

Spectrophotometry - Using different wavelengths of light to analyze materials.

Xylanase - An enzyme ehichs breaks down xylans, a type of carbohydrate.

Chairman's Report

Delivering Research Results to the Pork Industry

Agriculture in Canada, including the hog industry, has another newsworthy year in 2004. Avian Flu joined BSE as new challenges the livestock sector had to meet. An early frost and tough harvest conditions coupled with lower prices tested our cropping industry.

At the Banff Pork Seminar in January 2004, top analysts were predicting a very poor hog market for the year. Instead a remarkable demand driven situation occurred resulting in much stronger prices than anticipated. At the same time, the exchange rate and trade problems were negative to Canadian markets. Tremendous change is underway in the hog industry with many production units and systems struggling and some ownership changing hands.

All of these situations point to the continued requirement for research that drives positive bottom lines. This is exactly what Prairie Swine Centre was designed to do and which it has been delivering. The Prairie Swine Centre is an important source of highly usable public research information. The Centre also provides contract research services to corporations from around the world who come here for the expertise and the facilities.

A consequence of the recent industry financial challenges, is that these firms and and agencies who contract research out to Prairie Swine Centre, have found their margins declining and less work is available forcing our management team to work harder to obtain this important work.

Perhaps of more concern though, is the maintenance and strengthening of core funding. This funding has come from the University of Saskatchewan and very significantly from the the provincial organizations on the Prairies. An unfortunate consequence of the kind of success that Prairie Swine Centre has had is that funding organizations, when looking at their own finances, might think that the Centre is getting along quite nicely and may not need as much support. This simply is not the case. More than ever, core funding from the traditional sources is essential.

The board and management of the Prairie Swine Centre all realize that fiscal responsibility is absolutely important. This is not unlike all of the organizations that we deal with. We think it is important though, to assure all of our stakeholders that even as fiscal management is continually tightened, core funding and contract research is essential to the future of the Centre.

Bryan Perkins
Chairman of the Board

The Board of Directors of Prairie Swine Centre because of limited time appointments, continues to change. While we miss the strong contributions of those retiring, at the same time we welcome fresh input and ideas of our new board members.

The board again wants to acknowledge the excellent work carries out by the management team and staff led by John Patience. Their dedication to our industry is much appreciated.

President's Report

"Prairie Swine Centre continues to conduct research focusing on improving the economic position of pork producers in Western Canada ."

New Challenges Bring New Opportunities

As pork producers, we know that our industry is one of cycles – of highs and lows. In 2004, we were able to look back on the weak prices of 2002 and 2003 and look forward to strong markets, based on a high demand for pork in the marketplace.

John Patience Ph.D.
President and CEO

Although pork producers are now reaping the benefits of higher market prices combined with lower feed costs resulting in a profitable situation, the Prairie Swine Centre continues to play a vital role by providing practical, useful information to producers to further improve productivity, enhance efficiency and therefore improve financial performance. Increasingly, we seek to balance the absolute necessity of cutting costs with the equally important goal of enhancing revenues. History is a demanding and sometimes painful teacher, and history has shown that success in pork production requires attention to both revenues and expenses, not just expenses alone.

Aside from a well-needed market rebound, this past year was also highlighted by a couple of significant events: the Focus on the Future Conference in Red Deer last March, and the celebration of the Pork Interpretive Gallery's (P.I.G.) first anniversary.

The Focus on the Future Conference is our main technology transfer event. Our Research Scientists present their newest information and we invite additional speakers to address topics of interest to pork producers. Last year, we welcomed Dr. George Foxcroft of the University of Alberta, and Dr. Gary Dial of Minnesota as our invited speakers. The Conference exceeded attendance expectations and the evaluations were highly favourable. Likewise the Interpretive Gallery's first full year of operation was a tremendously successful one, attracting more than 2,000 visitors, from across the Prairies and literally from around the world. While our primary target audience remains the Prairie region, we are delighted to welcome guests from the U.S., Europe and Asia. Despite the diversity of our guest's geographic origins, the visitors were unanimous in their enthusiasm and positive feedback on the Gallery and its objectives.

This theme of diversity has also been evident in the research we have conducted over the past year at Prairie Swine Centre. Among the highlights our Research Scientists have accomplished is research to determine the advancement of the adoption of net energy and its application in Western Canada. On the basis of input from the industry, we've continued to study energy requirements of pigs, and more specifically, energy levels in the diet and the impact energy has upon on profitability. Other research of note undertaken over this past year includes nutrition studies into a variety of feed ingredients, such as ethanol distiller byproducts, mustard meal, flax and field peas. Further complementing that research, is our continued work dealing with ingredient variability. This is particularly beneficial in years such as this past one where the market is saturated with poor quality feed.

We've also continued to look at ways of reducing variability in pig growth patterns and managing that variability to minimize its impact on net income.

Our work on the housing of sows in both group situations and gestation stalls has also allowed us to maintain our focus on the importance of social issues in the industry. And we continue to work on research involving interior air quality with specific emphasis on H_2S, ammonia and odour.

To summarize, we are continuing to do research that focuses both on improving the economic position of pork producers in Western Canada as well as addressing important social issues such as animal welfare and the environment.

Although much of our work is complex and technical in nature, we are blessed to have a highly competent, professional and dedicated staff that contributes to our goals and mandate. I would like to take this opportunity to thank them for their diligence, professionalism and commitment, and am very mindful of the fact that without them, Prairie Swine Centre would not have earned the success and recognition it presently enjoys. Whether it is our production staff who provide daily care to the animals, research technicians and graduate students who conduct the experiments, administrative staff who keep the wheels of our business turning, our technology transfer staff who keep information flowing to the pork industry or our Research Scientists and assistants who direct and oversee our research program, each contributes in an essential way to our success.

Similarly, I would also like to recognize the important contribution of our Board of Directors. By providing both commitment as well as one of the linkages between the Centre and the industry, the Board serves an extremely important role not only in providing direction to the Centre, but also serving as a barometer for industry reaction. We welcomed two new Directors to our Board this year, Mr. Daryl Possberg of Humboldt, SK and Ms. Jacquie Gibney of Regina, SK. This past year also saw the retirement of two Directors, Ms. Marilyn Jonas of Saskatoon, SK and Mr. Marten Wright of Outlook, SK, as well as the re-appointment of Mr. Mac Sheppard, our Secretary/Treasurer and longest-serving Director. Welcome to our new Directors, and many thanks to those retiring from our Board.

Organizations like ours are based on a diversity of funding, but key to it all is that received from the pork producers, through Sask Pork, Manitoba Pork Council and Alberta Pork and from the Province of Saskatchewan. Their continuing support is a keystone to our success, and provides the basis upon which we recruit funding from more than 30 different companies and agencies from across Canada and around the world. A list of all funders appears at the back of this annual report.

"Organizations like ours are based on a diversity of funding, but key to it all is that received from the pork producers."

Report from the Manager - Operations

Fine-Tuning Production Improves the Bottom Line

Production at Prairie Swine Centre Inc improved slightly over the last fiscal year 2003-2004, with sales reaching a record high of 7,613 animals marketed from the herd with an average inventory of 310 sows. Average number born alive increased at the start of this last fiscal year, but pressure from a caesarean section project last year, affected farrowing rate and pre-wean mortality.

Brian Andries B.Sc.
Manager, Operations

Caesarean sections were performed on a total of 87 sows delivered from Pig Improvement (Canada) Ltd. out of a herd in Manitoba and one in Saskatchewan. A decision was made to change genetic lines to accommodate production and research activities at Prairie Swine Centre. As well, the caesarean section (c-section) procedures were used as a training tool for graduate students, technicians and production staff as they assisted in all protocols associated with the project. Sows were delivered to the off-site facility of the PSC Elstow Research Farm Inc. where they were housed and where the surgeries were performed. Piglets were derived under sterile conditions, after passing through an iodine bath, resuscitated and put on newly farrowed sows at both the Floral and Elstow locations.

"The completion of three nurseries assist in increasing production efficiency, improve animal health and expand research capabilities for starter trials"

The project ended in June 2004 and we were able to derive, from 87 sows, a total of 478 replacement females and 573 males that were sold as market animals. Initial targets required that 400 replacement females would be derived from a total of 100 sows. The project averaged 12.08 born alive with a 13.45% pre-wean mortality. This mortality included piglets that could not be resuscitated on the table during the procedure. A total of 3-5 c-sections were performed on a daily basis so there was a possibility that 50-60 piglets were fostered on sows, who themselves were producing 11 piglets at birth. Procedures were implemented to maintain a normal pre-wean mortality resulting in a number of litters being weaned early using these sows as foster moms, as litters were bumped up to accommodate c-section piglets.

Other changes we have implemented to improve reproductive performance at both facilities is to develop a consistently executed gilt development program. As Prairie Swine Centre Inc. is a closed herd all replacements are derived internally. Gilts will be housed in a remodelled finisher barn that has a stimulation room at the west end of the barn. Here, we will be moving groups of gilts to boars on a daily basis, starting at 80 kg of weigh, up to 42 days after the start of stimulation. Gilts not cycling by this time will be sold as market animals.

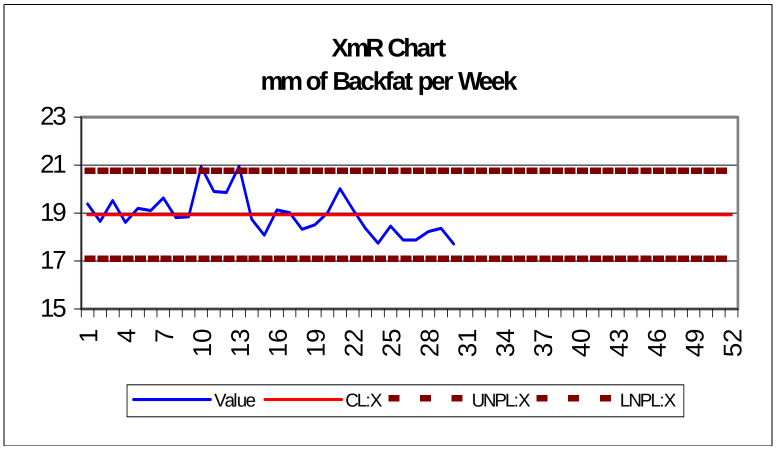
Prior to January 2004, all semen used for artificial insemination was collected on farm. In consultation with Pig Improvement (Canada) Ltd. a decision was made to utilize the company's top terminal sires out of their herd in southern Saskatchewan. Progeny from these boar lines were born mid-April, 2004 and began marketing in September 2004. Improvements in carcass quality is apparent from the following graphs:

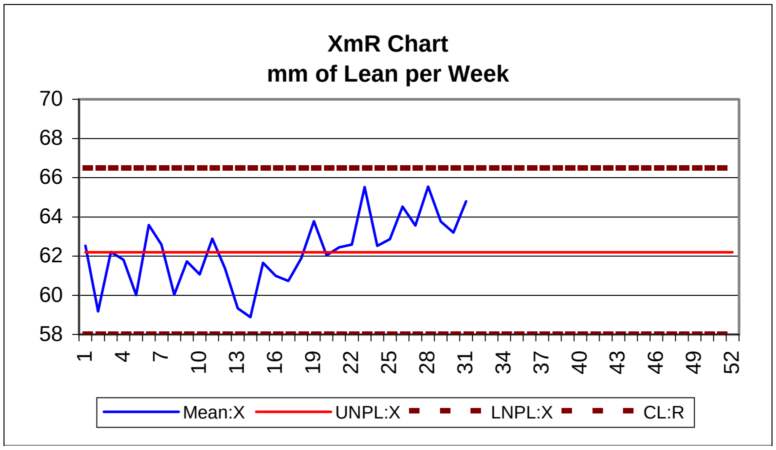
Please note that week 17 indicates the start of the first marketing of animals using terminal sires from boars out of this PIC stud (Aurora). By the start of week's 21-22 all animals being marketed would be from Aurora boars. An increase in index and total lean and a drop in mm backfat from week 17-31 are indicated.

Table 1. Production parameters for the 2001-2004 fiscal years

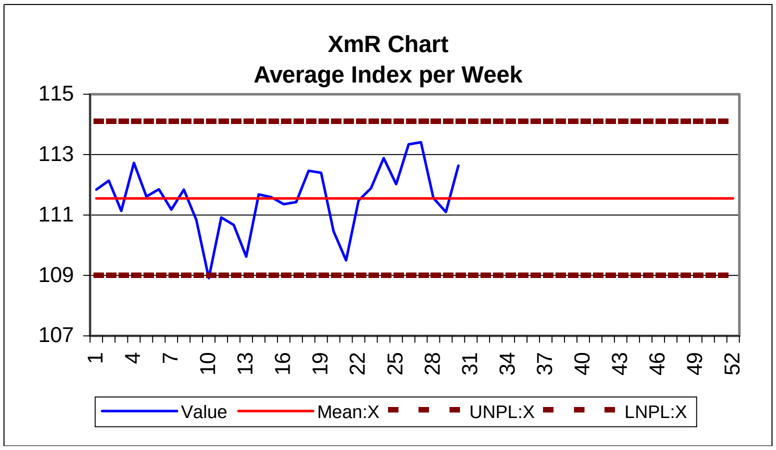
	2001-2002	2002-2003	2003-2004
Sow farrowed, #	750	799	759
Farrowing rate, %	88.1	87.2	82.0
Pigs born alive/litter	11.0	10.7	11.2
Pre-weaning mortality	10.9	10.0	12.8
Litters weaned	754	793	757
Pigs weaned	7,415	7,618	7,759
Pigs weaned/female inventory	23.9	23.4	24.2

Marketing within core from the Floral facility has become easier to achieve this last fiscal year by successfully contracting a finisher barn just north of the city of Saskatoon. Prairie Swine Centre has only room to finish 5,500 animals per year and we are now selling over 7,000 animals. Freedom to increase dress weight during this time of low feed prices has a beneficial effect on the bottom line. Scheduling of research rooms has also become easier due to this contract finisher agreement. We can more readily accommodate experiments requiring extended days to market or reduced numbers of animals on test as compared to a normal room fill.





Fiscal year 2004 saw the completion of 3 new nurseries and expansion of the 3 existing nurseries constructed in 1994 to increase production efficiency, improve animal health and welfare and expand our research capabilities for starter trials. Research was the considering factor in the design process and as the existing nurseries currently use group sizes of 96 or 120, this format would remain.



"New genetics and improved carcass characteristics contribute to a profitable 2004"

Report from the Manager - Information Services

What's Your Brand Anyway?

'Everything counts' could be the most accurate slogan that a business needs to live up to in the eyes of their customers. During the year there are numerous opportunities to interact with our clients - pork producers and their suppliers. These include Annual Reports, Centred on Swine newsletters, websites and bi-weekly email updates, meetings and barn tours. Each interaction leaves an impression that either reinforces your 'Brand' or detracts from it. Yes the Prairie Swine Centre Inc. has a 'Brand'. Although it may not be as well known as some consumer products brands you may be familiar with, it evokes a certain reaction based on your experience. Of course all organizations hope to be well thought of, but it takes more than a colourful logo and a catchy mission statement to be an effective organization. It also takes much more to have a 'Brand' that is recognized for certain qualities and evokes an emotional response that, in our case, encourages pork producers to stop and consider "how can I use this information to improve profits, welfare, barn environment, staff productivity, etc. in my barn".

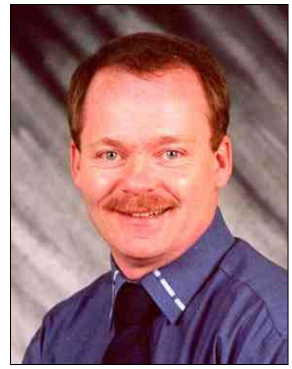
As part of the 5-year strategy completed two years ago, interviews and opinions of customers gelled around a few important points in defining the Prairie Swine Centre brand. That is, research and the resulting extension/ communication efforts needed to embrace two qualities to be of interest to our clients – Original and Practical.

"Your 'Brand' is the total impression of all direct and indirect contacts between your customer and your organization"

Derrick Coupland, Blacksheep Strategy Inc., Winnipeg

Table 1. Annual Technology Transfer Activities for 2004

Activity	Frequency/ Distribution
Annual Research Report	1 / 3,000
Centred on Swine	4 / 4,200
Telephone Inquiries	500+
Speaking Engagements	60+ / 2,000
Industry Magazine Article	8
Fact Sheets	2
Training Program (H_2S Awareness)	45 / 400
Posters at Conferences	8
Website Visitors	54,000
Bi-weekly e-mail	25 / 270
Focus on the Future	1 / 130
Farm Calls	30



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

To give this concept a visual image, a new logo was developed for special publications that focused on research that is ready to apply now. These first started appearing in provincial pork newsletters this year and will appear once a month as a new way to increase exposure. Few words, heavy on application and financial benefits, and short on describing experimental procedures, these pieces are designed to reside on the staff room table, in the coffee room or bathroom. These sheets, simply known as RESULTS, provide an inexpensive way to keep as many people as possible on your farm aware of what is new and what it can mean to the future of your farm.

As always we welcome hearing from you about how well our 'Brand' is meeting your needs.

Pork Interpretive Gallery (P.I.G.)- A Unique Science Centre

A Science-based Learning Experience

The Pork Interpretive Gallery continues to educate a diverse group of people about pork production. The interest steadily grows with respect to the operation of modern pork producing farms and the science-based facts that confirm the importance of pork in the food industry.

The tour experience provided by the Interpretive Centre fits nicely with the Grade 5 curriculum guide and has been considered a valuable and educational event by many of the Saskatchewan teachers. Grade 7/8 teachers also take advantage of the guided tour to compliment the grade 7/8 Social Studies program. The educational displays in the Interpretive Centre have been designed for students grade 4-10 and many of the visitors are within this age category.

A break down of the 29% of visitors categorized as the general public reflects the diversity of those that view the gallery. This category consists of pork producers and their families, industry sales representatives, food processing companies, church groups, international and national visitors, veterinarians, scientists, researchers and the list goes on. Visitors traveling from around the world, Spain, China and the United States are just a few examples of the interest the P.I.G. has drawn. The guided tours are pre arranged and often geared specifically to the group attending.
The final phase of construction on the newly constructed facility has been completed with the installation of floor covering. The bright tiles and strategically located coloured squares are a true asset to the gallery and enhance the experience of the visit by spectators. Thank you to Pig Improvement Company for initiating the "*PIC Challenge".* This helped us break our $1 million goal and made it possible to complete the flooring

Deborah Ehmann
Assistant Manager, P.I.G.

The Interpretive Centre continues to add new information to its portfolio. Three new displays will be added to the exhibition in the near future. A Farm Safety Display supported by the Canadian Agricultural Safety Association will be created to increase awareness by youth in the area of safety in pork production in Canada. The second project will expand the existing careers display at the interpretive centre to include the nutritionist, feed truck driver, geneticist, sales representative, lab technician and veterinarian. It is a shared venture with the Canadian Adaptation and Rural Development program. The third exhibit will reflect the current research on Greenhouse gas emissions.

Technology Transfer continues to be a critical component of the objectives of the Pork Interpretive Gallery, which is to provide a resource for the prairie pork industry in its communications strategy. Information has been delivered through a variety of ways. School group presentations, workshops, tradeshows, mail outs and information packages.

The Interpretive Centre is a great venue for the pork industry to disseminate information. The success of the campaign within the industry, to enhance the understanding of the pork industry, including its social and economic impact by the general public, relies on the strength of the communication network established among those in the industry and supporting stakeholders.

"The opportunities to communicate with people within the pork industry and the general public are endless"

Prairie Swine 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 our research programs by operating efficient, highly productive and profitable pig herds at its research sites while concurrently 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, cooperative 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 of 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

Crowding Effects on Performance on Fully and Partially Slatted Floors

T. Done, S.M. Hayne and H.W. Gonyou

Summary

Crowding affects the productivity of grow/finish pigs and it is generally believed that floor types differ in required space. This study was designed to determine if there is a significant interaction between the two factors. Crowding resulted in a reduction in ADG, but the type of flooring did not make a difference.

Introduction

Floor space allowance remains one of the more contentious issues in the debate on modern farm practices and animal welfare. It is generally believed that space requirements for maximum growth will vary with housing conditions. The Code of Practice recommends that pigs on partially slatted floors be provided with more total floor area than those on fully slatted floors. However, some research has suggested that there are no differences in the effect of crowding on these two floor types. This study was conducted to gain a better understanding of space required for pigs housed on either fully or partially slatted floors.

Experimental Procedures

Four blocks of 216 grower pigs (average initial weight = 37 kg) were assigned to two floor types (full or partial slats) and three levels of floor space allowance (0.38, 0.54, and 0.78 m^2/pig). The lowest space allowance was discontinued after the grower phase. The space allowance coefficients, where k = area (m^2) / BW (kg)$^{.667}$, were approximately 0.025, 0.036, and 0.052 for the grower phase (to 58 kg), and 0.026 and 0.037 for the remaining treatments in the finisher phase (to 95 kg). Pigs were fed ad-libitum a series of mash diets from wet / dry feeders. Within each block, pigs were assigned to two pens (18 pigs/pen) within each floor type x space allowance combination. Pens were balanced for sex within pens. Pigs were weighed and feed disappearance summarized on a weekly basis.

Results and Discussion

ADFI was not affected by floor type or floor space allowance in either the grower or finisher phases. ADG tended to be less on partially than on fully slatted floors during the grower phase (1.036 vs. 1.072 ± 0.010 kg/d, P = 0.08), but did not differ in the finisher phase. Pigs on the lowest floor space allowance grew slower than pigs on the other two space allowance treatments (1.013 vs. 1.067 and 1.083 ± 0.010 kg/d, for 0.38, 0.54, and 0.78 m^2/pig, respectively; P = 0.001) during the grower phase (Figure 1). ADG tended to be reduced by crowding during the finisher phase (0.953 vs. 1.001 ± 0.013 kg/d, for 0.54, and 0.78 m^2/pig, respectively; P = 0.06) (Figure 2). There were no significant interactions between floor type and space allowance.

Conclusion

Although crowding to a space allowance coefficient of 0.026 resulted in a reduction in ADG, there was no evidence that this effect differed depending on whether the floor was fully or partially slatted.

Acknowledgements

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

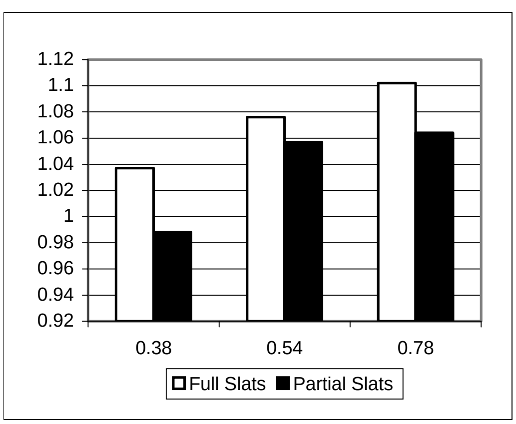


Figure 1. Effect of floor space allowance and floor type on average daily gain (ADG) of pigs during the grower phase.

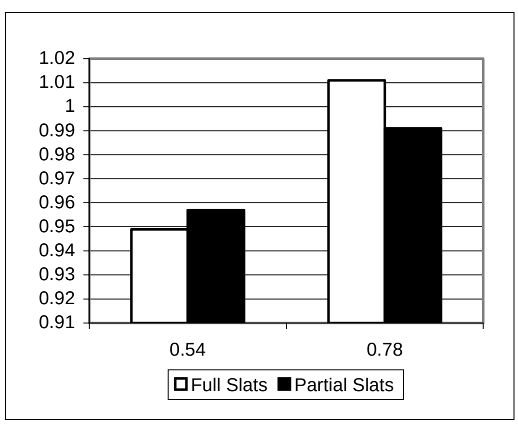


Figure 2. Effect of floor space allowance and floor type on average daily gain (ADG) of pigs during the finisher phase.

"Pigs on the lowest floor space allowance grew slower than pigs on the other two space allowance treatments."

Effects of Stall Width and Sow Size on Behaviour of Gestating Sows

Y. Z. Li and H. W. Gonyou

Summary

It is recommended that gestating sows of various weights should be kept in different sizes of stalls. However the proper size of stall has not been well defined. A study was conducted to evaluate stall width by assessing the interaction between stall width and sow size on behaviour. As stall width decreased, sows spent less time standing, more time sitting, and their udders extended into the adjacent stall more frequently. Using udder extension during less than 50% of lateral lying as a criteria for stall width, a 65 cm (26") stall is adequate for gilts and small sows, but a 70 cm (28") stall is required for larger sows if in stalls for the entire gestation period.

Introduction

Gestation stalls are usually uniform in size within a farm in North America despite the wide range in body weights among gestating sows (150 to 350 kg). The adequacy of typical stalls to accommodate large sows is questioned. The Code of Practice suggests producers use different sizes of stalls to accommodate various sized sows. However the proper stall size for sows of different body size is not well defined. As an inadequate stall size is likely to affect the behaviour of the sow, a study was conducted to evaluate stall width by determining the effects of stall width, sows size and the interaction on sow behaviour.

"Pork producers should use a variety of stall widths to accommodate various sized gestating sows."

Experimental Procedures

A total of 184 gestating females were weighed post breeding and before taken for farrowing. Based on their parity and body weight post breeding, they were categorized into gilts, small sows, medium sows, and large sows. They were assigned to each of four widths (55, 60, 65 and 70 cm; 22, 24, 26 and 28") of stalls for the entire gestation period, with the exception that gilts were not assigned to 70 cm stalls. During wk 4 and 14 of gestation, 24-h behavioural observations were conducted to assess sow postures (lying, standing, and sitting), posture changes, and whether their udder extended into the next stall while lying laterally.

Results and Discussion

At post breeding, average body weights of gilts, small, medium and large sows were 145, 180, 216, and 259 kg, respectively, and the animals gained 60-80 kg during pregnancy (Table 1). At wk 14 of gestation, sows spent more time lying (82.5% vs 77.5% of their total time; P<0.001) and less time standing (14.4 vs 19.8%;

Table 1. Body weight of animals

Item	Gilts	Sows		
		Small	Medium	Large
N	39	47	45	53
Avg. Parity	0	1.4	2.8	4.8
BW1, kg	145±13	180±14	216±10	259±21
BW2, kg	223±20	250±24	282±21	316±22
ΔBW, kg	78	70	64	57

BW1 = average body weight post breeding
BW2 = average body weight before farrowing
ΔBW = BW2 - BW1

P<0.001) than at wk 4. The proportion of time spent standing increased in wider stalls (Fig 1, P=0.02), but sitting decreased (P=0.001). Extension of the udder into the adjoining stall was expressed as a proportion of time spent lying laterally. This increased from wk 4 to wk 14 (20.8 vs 60.0%; P<0.001), with larger sows (51.0 vs 77.8%, for gilts and large sows during wk 14; P=0.01) and in narrower stalls (23.5 vs 91.7%, for 70 and 55 cm stalls during wk 14; P<0.001). Extension of the udder into the adjoining stall was significantly affected by the interaction of stall width and sow size (P<0.05), indicating that large sows in narrower stalls were quite crowded (Fig 2). Using the criteria that the udder should not extend into the adjoining stall more than 50% of the time that a sow is lying on her side, we suggest that a 55 cm stall is suitable for gilts and small sows, a 60 cm stall for medium sows, and a 65 cm stall for large sows during the early stage of gestation (wk 4), as would be the case if sows were moved into group housing after implantation. But in later stages (wk 14) gilts and small sows should be housed in 65 cm, and medium and larger sows in 70 cm stalls.

Conclusions

Pork producers should use a variety of stall widths to accommodate various sized gestating sows. If stalls are used for the entire gestation period, 65 cm stalls appear to provide adequate space for gilts and small sized sows, and 70 cm stalls for larger sows.

Acknowledgements

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

Social Factors Affecting Injury Levels and Behaviour of Sows in a ESF System

M.L. Strawford, Y. Z. Li and H. W. Gonyou

Summary

The total number of injuries detectable on sows increased until 28 days after regrouping before declining. First parity sows and post-implantation sows ate later in the feeding cycle, while first parity sows and unfamiliar sows rested in the less optimal areas of the pens. Thus, the behaviour of older, familiar and pre-implantation sows indicates that they are experiencing less stress during regrouping.

Introduction

Regrouping is a stressful time for pigs. When sows are regrouped shortly after breeding, stress may alter behaviours and result in a decrease in farrowing rate. The severity of the stress the sows are experiencing can be reflected in injuries, eating order and resting locations. The goal of this study was to determine the effect that stage of implantation, familiarity with penmates, and parity have on the behaviour.

Experimental Procedures

Groups of about 35 sows were regrouped into either static or dynamic pens fed by an Electronic Sow Feeding System. Within each group, focal sows were chosen based on the following criteria: Stage of Implantation (pre < 7 vs. post > 35 days post-breeding), Familiar vs. Unfamiliar (with majority of pen mates based on previous gestation group), and Parity (1 vs. 2&3 vs. 4+). In order to determine the effect that social stress would have on the sows' behaviour the following data were collected: fresh and healed injuries on 18 regions of the body; entry order into the feeder; and, the area in the pen where each sow was resting (for three days).

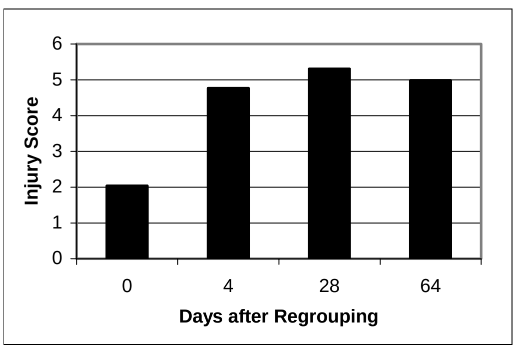


Figure 1. The total injury scores of sows on days 0, 4, 28 and 64 after regrouping into the ESF pen.

Results and Discussion

The total injury scores rose until 28 days after regrouping, at which time they started to decrease (Figure 1). There were not any effects due to stage of implantation, familiarity and parity on injury scores. As seen in Figure 2, the younger and post-implantation sows ate later in the feeding cycle than the older and pre-implantation sows. In relation to where the sows rested in the pen, familiar and older sows rested on the solid portion of the pen more often than the younger and unfamiliar sows (Figure 3). The social factors studied affected the priority of access to both the feeding station and preferred lying areas in the pen.

Conclusion

After regrouping, the younger, unfamiliar and post-implantation sows showed behaviours indicating that they experienced mores social stress than the older, familiar and pre-implantation sows.

Acknowlegements

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork and ADF. Additional project funding provided by Ontario Pork, NSERC and AAFC.

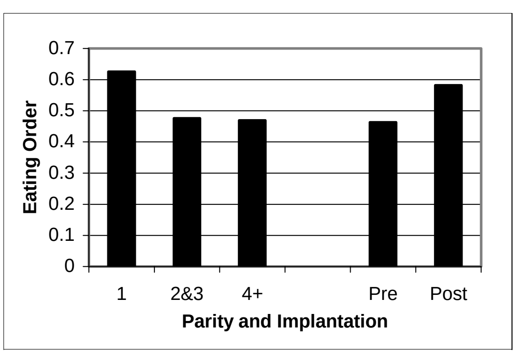


Figure 2. The effect of parity and stage of gestation on feeder entry order 4 days after regrouping into the ESF pen.

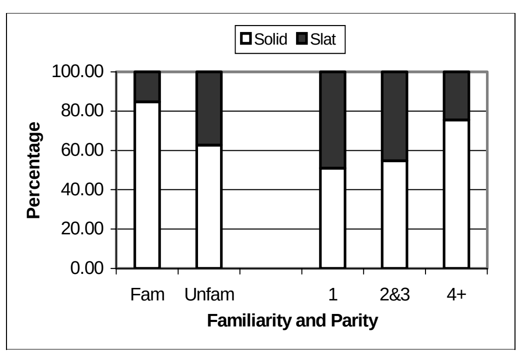


Figure 3. Impact of familiarity and parity on the relative proportion of time the sows spent lying one week following regrouping

"The behaviour of older, familiar and pre-implantation sows indicates that they are experiencing less stress during regrouping."

Engineering Controls Reduce Hydrogen Sulphide Exposure in Swine Barns

B. Predicala[1], S.P. Lemay[2], C. Laguë[3], S. Christianson[1]

Summary

Three engineering control measures were developed and tested for effectiveness in protecting swine barn workers from exposure to hydrogen sulfide (H_2S) gas during manure handling events. A remote manure pit plug pulling system allowed the worker to pull the manure pit plug from outside the room. A water sprinkling apparatus was also devised, which resulted in 79% reduction of H_2S gas concentration under optimal laboratory conditions. A manure scraper system was installed to remove manure daily from the manure pit of a grower-finisher room. Preliminary measurements showed that H_2S levels were 80 to 96% lower in the scraper room than in a similar room with a conventional pull-plug system.

Introduction

High levels of H_2S can have detrimental effects on both workers and swine. Previous research by the Prairie Swine Centre Inc. (PSCI) indicated that workers are at risk of exposure to potentially hazardous H_2S levels when performing manure management tasks, such as pulling manure pit plugs. The main goal of this project is to develop practical measures that can prevent or reduce worker exposure to high H_2S concentration in swine buildings. Three different systems were investigated in separate modules.

"A water sprinkling apparatus resulted in 79% reduction of H_2S gas concentration under optimal conditions."

Module 1 – Improved Design for Pit Plugs

In this module, an improved pit plug concept that allowed for pulling the plugs from a remote location was designed and evaluated (Fig. 1). The system was installed in two grower-finisher rooms at PSCI and tested by measuring H_2S concentrations using a H_2S monitor (Draeger Pac III monitor with a H_2S sensor, Draeger, Lübeck, Germany) during the plug-pulling operations.

After examining several plug designs, the extended cone plug was selected and installed. Monitoring of H_2S levels during nine plug-pulling events showed that the maximum H_2S concentration in the room over the plug area was 68 ppm, while corresponding concentrations at the alleyway near the winch was 0 ppm. Hence, the system was very effective in protecting the worker from being exposed to H_2S by allowing the worker to perform the task away from the plug area.

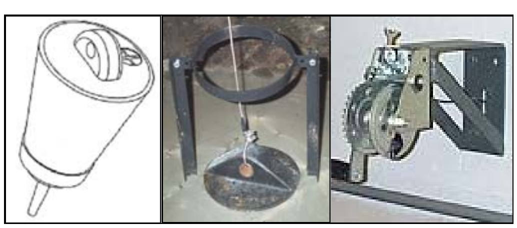


Figure 1. Improved pit-plug design showing the (a) extended cone plug, (b) with cable attached and plug-height stop, and (c) the cable-winch system for remotely pulling the plug from outside the room.

Module 2 – H_2S Abatement by Water-based Liquid Spray

Because H_2S is water soluble, it was hypothesized that spraying a water-based liquid over agitated manure would reduce emissions into the air. A laboratory spray chamber was set up to determine the impact of a water-based spray on H_2S levels in the chamber (Fig. 2). Preliminary tests were done to investigate the reduction in H_2S levels as affected by various parameters such as type of spray nozzle, water pressure, temperature and pH, as well as the use of various chemical additives.

Laboratory tests with various combinations of test parameters consistently reduced the concentration of pure H_2S gas released into the chamber. Using a hollow cone nozzle at 200 kPa with water at pH = 9 resulted in a 79% reduction of the peak H_2S levels. The treatment was applied to a set of barrels filled with swine manure. In four control barrels where no spray was applied, manure agitation produced an average of 148 ppm, with a peak reading of 520 ppm measured from the exhaust air. However, application of the water-spray treatment increased the average and maximum H_2S concentrations to 273 and 690 ppm, respectively. Because these were not consistent with the observations in the laboratory study, it was suspected that other gases generated in the manure barrel affected the Draeger Pac III monitor. Additional tests are on-going to investigate the water-spray treatment further.

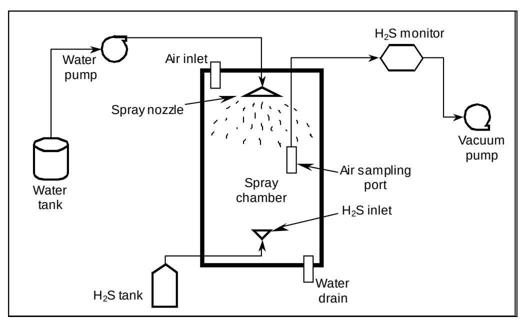


Figure 2. Schematic diagram of laboratory set-up used to determine the effect of water-based spray on H_2S levels in the chamber.

[1] Prairie Swine Centre Inc., [2] Institut de Recherche et de Développement en Agroenvironnement, [3] University of Saskatchewan

Figure 3. Scraper blade used for daily removal of manure from the pit. The manure pit has drains at both ends, through which the scraped manure was emptied to the sewer line.

Module 3 – Manure Scraper System to Reduce H_2S Levels

In this module, a manure pit scraper system (Fig. 3) was installed in a grower-finisher room to remove swine manure on a daily basis. Its effectiveness was evaluated by comparing the air quality in the scraper room and a similar room (Control) with conventional manure pit-plug system.

Table 1 summarizes the maximum H_2S concentrations measured at two locations in the rooms. Compared to the control room, the maximum H_2S concentrations were lower in the scraper room by an average of 80% over the plug area and by an average of 96% over the middle pen. Additionally, the maximum H_2S levels in the control room exceeded the 15-ppm ceiling occupational exposure limit (OEL) value on three occasions during the two trials, while no peak H_2S readings were higher than this limit value in the scraper room. The ceiling OEL is the maximum concentration of a biological or chemical agent to which a worker may be exposed, i.e., no worker should be exposed to any levels above this limit at any time.

During the two trials, significant levels of ammonia were measured in the incoming inlet air for both rooms, possibly due to recirculation of air exhausted from the fans into the supply air as well as from possible back draft of ammonia from adjacent rooms into the barn attic. The weekly average ammonia concentrations measured at the exhaust was significantly ($p<0.05$) higher in the scraper room (11.3 ppm, SD = 2.3 ppm) than in the control room (9.8 ppm, SD = 2.1 ppm), although the mean difference was smaller than the indicated accuracy of the ammonia analyzer. The calculated ammonia emissions were about 44% higher in the scraper room, which was attributed to the formation of a film of excreta on the pit bottom surface after scraping; this has been previously reported as possibly causing increased ammonia emissions in scraper systems. However, the observed ammonia levels were still lower than the 25-ppm OEL for ammonia, despite the presence of ammonia in the incoming air. Additional tests are on-going to determine the effectiveness of maintaining a layer of standing water at the bottom of the manure channel to control ammonia emissions.

Table 1. Summary of maximum H_2S concentration (ppm) measured in the scraper and control rooms.

		Control		Scraper	
	Date	Over plug	Middle pen	Over plug	Middle pen
Trial 1	10-Mar-04	4.0	2.0	0.0	0.0
	24-Mar-04	0.0	0.0	0.0	0.0
	7-Apr-04	9.0	0.0	11.0	7.0
	21-Apr-04	12.0	4.0	0.0	0.0
Trial 2	30-Jun-04	12.0	2.0	0.0	0.0
	21-Jul-04	95.0	N/A	6.0	N/A
	11-Aug-04	40.0	30.0	2.0	0.0
	25-Aug-04	30.0	10.0	1.0	2.0
	Average	25.3	6.9	2.5	1.3
	SD	31.2	10.8	4.0	2.6

N/A – data not available, instrument malfunction

Conclusions

A remote manure plug pulling system was successfully developed. Results showed that the system was effective in preventing worker exposure to H_2S by allowing the pulling of the plugs from the alleyway. A water-spray treatment showed consistent reduction in H_2S levels in a laboratory study. However, application of the treatment on agitated manure showed opposite effect on H_2S. A manure scraper system used for daily manure removal from a swine room was effective in reducing H_2S to levels below the maximum exposure limit for worker's safety. The system generated higher ammonia levels, although peak readings did not exceed the ammonia exposure limit value. Additional tests are being conducted to further investigate both the scraper and the water-spray systems.

Acknowledgements

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork, and Saskatchewan Agriculture and Food Development Fund. Project funding provided by Sask Pork, Agriculture Development Fund, and PIC Canada.

"Preliminary measurements showed that H_2S levels were 80 to 96% lower in the scraper room."

Manure Handling Systems Reduce Air Contaminants in Swine Barns

K.J. Stewart[1], S.P. Lemay[2], C. Laguë[3], E.M. Barber[3], and T. Crowe[3]

"Both systems analyzed proved efficient at reducing the air contamination from the manure."

Summary

Two manure-handling systems, a washing gutter and an inclined washed conveyor belt, were tested to determine which system best eliminates all manure contamination from the experimental chambers in an air quality laboratory. Both systems proved efficient at reducing the air contamination from the excreta. However, neither system totally eliminated the release of contaminants to the airspace.

Introduction

To better understand the sources of air contamination in an intensive swine operation, this study will look at various factors separately (i.e., feed, manure, and the animals themselves), and attempt to eliminate the effect of each factor on air quality. It is anticipated that once the effect of each factor is reduced to zero, these factors can then be varied individually to find out their effect on overall air quality. The first focus of the study was the manure handling system. Two methods of removing the manure were tested, one was a washing gutter using nozzles and pressurized water to clean the dunging area (Fig. 1), and the other was a washed, inclined conveyor belt (Fig. 2). The objective was to attain zero air contamination from the manure in the room using these manure handling systems.

Experimental Procedure

An air quality laboratory was built at the Floral facility of the Prairie Swine Centre Inc. The laboratory consisted of two rooms, each lined with stainless steel to reduce absorption of contaminants by the room surface. The washing gutter was installed in one room, and the inclined conveyor belt system in the other room. Testing of the manure handling systems focused on the frequency of cleaning the dunging areas. Three different frequencies were tested - every half hour, every hour and every two hours. Groups of 10 female pigs weighing about 30 kg each were used in each room, and data was collected over one week in each trial. Three trials were run at each frequency for a total of nine trials in each room. Ammonia levels were used to measure the effectiveness of the systems (as ammonia comes only from the manure), and were measured at the inlet and outlet of each room over a period of a week.

Results

The average ammonia emissions from the washing gutter and the conveyor belt rooms were 48.7 mg day^{-1} kg$_{pig}^{-1}$ and 57.0 mg day^{-1} kg$_{pig}^{-1}$, respectively. Even though these emissions were 38% and 47% lower than previous observations from grower-finisher rooms with a conventional pit-plug design in the same swine building, both systems failed to achieve near zero ammonia emissions. There were no differences at a statistically significant level ($P>0.05$) between the ammonia emissions from the two manure handling systems nor among the three frequencies tested (Fig. 3).

Figure 1. Water nozzles used to wash the manure from the gutter portion of the pen.

Figure 2.. Conveyor belt system used to remove manure from the pen.

Implications

Another manure handling system will have to be found to achieve zero contamination levels for testing of the origin of contaminants. The washing gutter system is recommended for health and productivity testing with a range of contamination levels, as it was simpler and easier to operate than the conveyor belt system.

Acknowledgments

Strategic funding for this project was provided by Sask Pork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by NSERC and Cement Association of Canada.

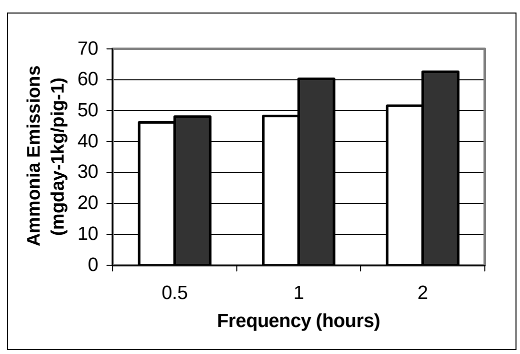


Figure 3. Average ammonia emissions from the experimental chambers over all the trials. Averages followed by the same letter are not significantly different ($P>0.05$).

[1] Prairie Swine Centre Inc., [2] Institut de Recherche et de Développement en Agroenvironnement, [3] University of Saskatchewan, Saskatoon, SK.

Greenhouse Gas Emission from NAP-Covered Earthen Manure Storage Basin

J. Peterson[1], J Agnew[1], C. Laguë[1,2], and E. Gaudet[1]

Summary

The objective of this project was to examine the effectiveness of a negative air pressure (NAP) cover in reducing greenhouse gas (GHG) emissions from an earthen manure storage basin (EMB). GHG emissions were measured from the same EMB when it was uncovered and covered with chopped straw in 2001, 2002 and 2003, and compared with the emissions from the NAP-covered EMB in 2004. The 2-cell EMB was located at the 600-sow farrow-to-finish operation of PSC Elstow research Farm Inc. near Elstow, Saskatchewan.

Introduction

As part of the Kyoto Protocol agreement, Canada committed itself to reduce its greenhouse gas (GHG) emissions during the 2008 – 2012 period at a level corresponding to 94% of the 1990 emissions (AAFC 2000). Agriculture, in general, accounts for 9.5% of the total (GHG) emissions in Canada, with N_2O and CH_4 contributing 61 and 38% respectively (AAFC 2000). It is also estimated that 42% of the agricultural GHG emissions originate from livestock operations and one third of these emissions are associated with manure management (Laguë et al. 2002).

Results and Discussion

The concentrations of the gases in the samples collected from the surface of the cover were very near ambient conditions, so the emissions through the cover were deemed negligible. Additionally, the nitrous oxide concentration of the exhaust samples was also negligible. The average emissions from the exhaust fans (average of primary and secondary cells) were 93 and 89 g of CO_2-eq/m^2-day for carbon dioxide and methane respectively.

Table 1. Comparison of GHG emissions from NAP-covered primary and secondary cells of an EMB

	g of CO_2-eq/m^2-day	
	CO_2 emissions	CH_4 emissions
Primary cell	131	129
Secondary cell	54	49

The NAP cover resulted in a 72 and 93% reduction in carbon dioxide and methane emissions respectively, compared to the uncovered surface (Figure 6). While these results show a significant reduction compared to the uncovered surface, the emissions from the NAP cover are not significantly lower than the emissions from the straw-covered surface.

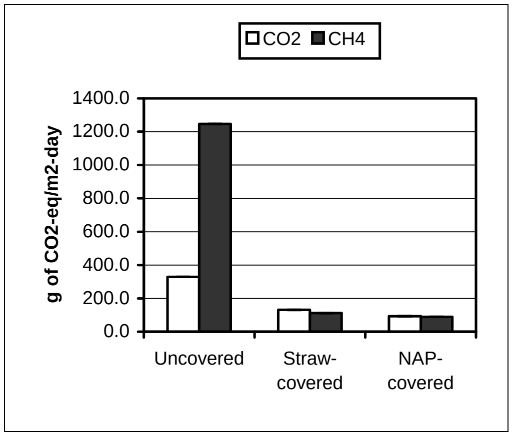


Figure 1. Overall GHG emission comparison among uncovered, straw-covered EMB in Saskatchewan.

Conclusions

Greenhouse gas emissions through the surface of the NAP cover were negligible, while the emissions from the exhaust fans were significantly lower than emissions from an open storage when expressed as g of CO_2-eq/m^2-day (72 and 93% reductions in carbon dioxide and methane, respectively). However, GHG emissions from the exhaust fans of the NAP cover were not significantly different than those from the straw-covered surface when expressed as g of CO_2-eq/m^2-day.

Nitrous oxide emissions from the exhaust fans were negligible. While the NAP cover showed only a minor improvement in greenhouse gas emission abatement compared to the straw-covered surface, the effectiveness of the cover at reducing odour emissions has been estimated to be as high as 99%. Additional benefits of the NAP-cover, such as the increased nutrient value and the ability to add biofilters at the exhaust fans to potentially further reduce emissions, should also be considered when assessing its overall performance.

Acknowledgements

Strategic funding provided by Sask Pork, Alberta pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund

"The effectiveness of the cover at reducing odour emissions has been estimated to be as high as 99%."

[1] University of Saskatchewan, Saskatoon, SK.., College of Engineering [2] Prairie Swine Centre Inc.

Dietary Phytase Reduces Phosphorus Excretion in Weanling Pigs

A.D. Beaulieu[1], J.F. Patience[1], and M. Bedford[2]

Summary

Excessive phosphorus (P) output in the manure is a concern because it can leach into groundwater and/or may limit manure application onto certain lands. The addition of phytase enzyme to the diet of weanling pigs decreased total and water-soluble P output in the manure. This effect was reduced when dietary calcium was high relative to P (Ca:P ratios above 1.7:1). Phytase had only modest effects on performance.

Introduction

The use of phytase in pig diets is rapidly increasing as extensive research has documented its efficacy in improving the digestibility of phosphorus (P) in cereal grains. This allows diets to be formulated with less total P (tP), resulting in decreased P output in the manure and potentially reducing feed costs. It is well known that when diets are formulated with less total P, the dietary calcium:P ratio (Ca:P) becomes extremely important in terms of maximizing the utilization of P. As the industry moves to diets with little or no excess P present, and the use of phytase increases, the need to clarify the Ca:P ratio increases.

"Addition of phytase enzyme to the diet of weanling pigs resulted in approximately 1.4 g/d per pig less phosphorus excreted."

It has been suggested that the environmental benefit of reduced phosphorus output in manure is partially dependent upon the solubility of the excreted P. If the use of phytase results in a greater proportion of the P excreted to be water soluble, then the environmental benefits may be reduced.

The objectives of this experiment were to: 1) examine the effect of the dietary Ca:P ratio on phytase efficacy, and 2) determine the effect of the phytase enzyme on the amount and form of the excreted P

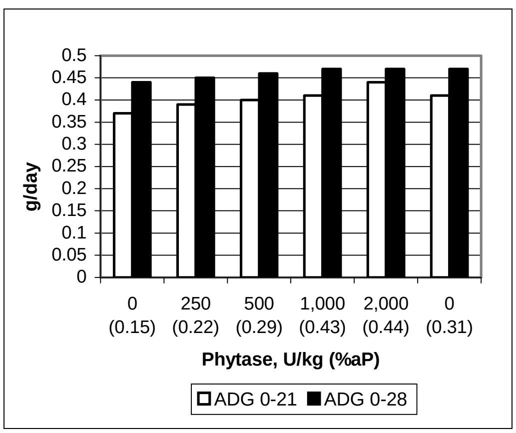


Figure 1. The effect of 0, 250, 500, 1000, or 2000 U/kg phytase on the ADG of weanling pigs (initial weight, 6.52 kg) during the initial 3 weeks of the trial (d0-21) or over the entire experimental period (d0 – 28). Numbers in parentheses refer to the calculated available phosphorus (aP). Dicalcium phosphorus was used to increase the aP concentration in the 0 (0.31) treatment.

Experimental Procedures

Our objectives were achieved through a series of experiments. All the experiments used weanling pigs fed diets based on corn, soymeal and barley. Dicalcium phosphate was added to achieve different concentrations of total P in the diets. Additionally, the diets were supplemented with the phytase enzyme in various amounts. Typically, 500 U/kg is the recommended addition level. Figure 1 shows the ADG of pigs fed diets with up to 2000 units per kg of phytase enzyme. The calculated available P in these diets is shown in parentheses. The first two diets (0 (0.15); 250 (0.22)) were assumed to be deficient in available P for pigs of this age.

In a second experiment, diets were formulated to contain 0.56, 0.86 or 1.18 % Ca and about 0.50 % P. The Ca:P ratios were therefore approximately 1.1, 1.7, or 2.3. Either 0 or 500 U phytase/kg was added to each diet for a total of 6 treatments.

Results and Discussion

In experiment 1, there was a modest improvement in growth rate with the added phytase. Phytase had no effect on feed intake and therefore feed efficiency improved. Figure 2 shows the effect of phytase on the amount of phosphorus excreted. Total excreted P ranged from about 4 g/pig/day when dicalcium phosphate was added to the diet (0(0.31) treatment) to 2.1 g/pig/day when the diet contained no added dicalcium

[1] Prairie Swine Centre, Inc. [2] Zymetrics, Wiltshire, UK.

phosphate and 1000 U/kg phytase enzyme (1000(0.43) treatment). Additionally, the P excreted as soluble inorganic (hatched bars) ranged from 75 to 80% of total P and was not affected by treatment. Therefore, the pattern of excretion of the soluble inorganic P was similar to total P; ie. decreased with the addition of phytase.

The beneficial effect of phytase on the excretion of total and soluble P was repeated in experiment 2 (Figure 3). Moreover, this experiment demonstrated that the effect of phytase is mitigated when the dietary Ca:tP ratio exceeds 1.7:1.

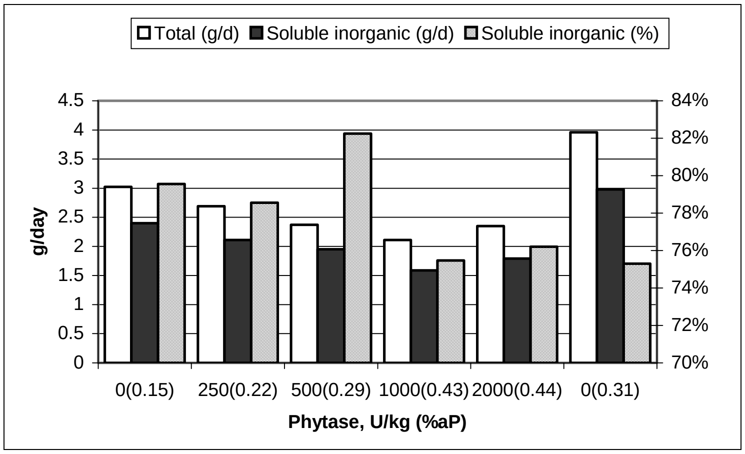


Figure 2. The effect of phytase on the excretion of total (solid bars, left axis) or soluble inorganic phosphorus (open bars, left axis) or soluble inorganic P expressed as a proportion of total P excreted (hatched bars, right axis). Numbers in parentheses refer to the calculated available phosphorus (aP). Dicalcium phosphorus was used to increase the aP concentration in the 0(0.31) treatment. Initial bodyweight averaged 21 kg.

Conclusion

The addition of phytase enzyme to the diet of weanling pigs resulted in approximately 1.4 g/d per pig less P excreted compared to the same diet with the phosphorus provided from an inorganic source (dicalcium phosphorus). The effectiveness of phytase is reduced at Ca:P ratios above 1.7. We saw no effect of phytase on the proportion of P excreted that was water soluble. Phytase allows us to formulate diets containing less total P and effectively reduces the excretion of total and soluble P.

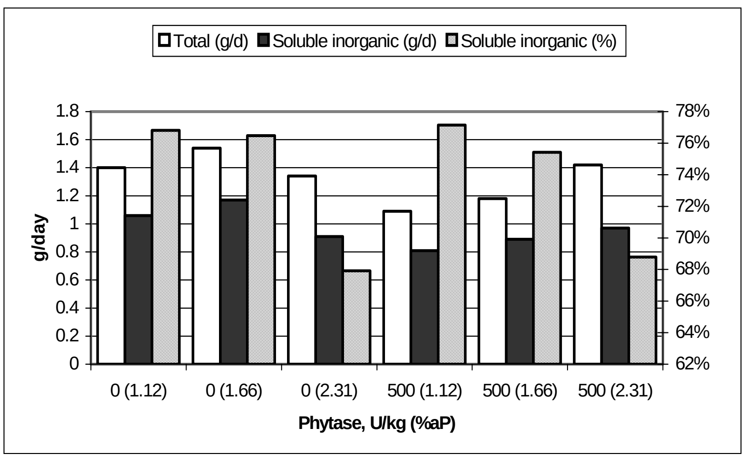


Figure 3. The effect of phytase and the dietary Ca:P ratio on the excretion of total (solid bars, left axis) or soluble inorganic phosphorus (open bars, left axis) or soluble inorganic P expressed as a proportion of total P excreted (hatched bars, right axis). Numbers in parentheses refer to the calculated available phosphorus (aP). Dicalcium phosphorus was used to increase the aP concentration in the 0 (0.31) treatment. Initial bodyweight averaged 9.1 kg.

"The effectiveness of phytase is reduced at Ca:P ratios above 1.7"

Acknowledgements

Strategic funding provided by Sask Pork, Alberta pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund. Project funding from Zymetrics Inc. is greatly appreciated.

Response of Growing-Finishing Pigs to Dietary Energy Concentration

J.F. Patience[1], A.D. Beaulieu[1], N. Williams[2], and D.Gillis[1]

Summary

The objective of this experiment was to develop an energy response curve for pigs in the growing and finishing phases of production. The diets varied in DE content (3.1, 3.2, 3.3, 3.4 and 3.6 Mcal DE/kg) and were fed from 25 kg to market. Feeding lower energy, lower cost diets, had no effect on ADG or on loin thickness, but did improve feed efficiency and reduced backfat thickness. These results indicate that lower energy diets may be used to increase net income. The applicability of these results amongst a diversity of commercial herds probably depends on feed intake, and the ability of pigs to increase feed intake on the lower energy diets. Nonetheless, the potential for substantially increasing net income warrants careful consideration of dietary energy levels during the growout period. In this experiment, return over feed cost varied by more than $10 per pig across the 5 dietary treatments.

Introduction

The primary objective of pork production is to produce lean meat in a cost effective and sustainable manner. Because energy is considered to be the most important driver of growth in the diet, achieving the full genetic potential for growth in the modern pig requires a clear and definitive understanding of the energy response curve in all phases of production. Despite the importance of energy in the design of commercial feeding programs, and the impact that daily intake has on energy supply, there has been surprisingly little information developed on animal response to energy intake. The little information that is available tends to emphasize whole body growth and reveals little in terms of the partitioning of energy into protein, lipid, water and ash. Establishing responses to nutrient intake levels is particularly critical in defining feeding programs to maximize carcass quality.

"In this trial, feeding lower energy, lower cost diets had no effect on ADG or on loin thickness, but did improve feed efficiency, and reduced backfat thickness."

Table 1. The effect of dietary energy density on body weight, ADG, ADFI and feed conversion over 3 phases of growth.

	Diet (Measured DE, Mcal/kg[1])						
Parameter	3.09	3.24	3.34	3.42	3.57	SEM	Regression
Phase 1							
Wt, kg (day 0)	31.17	31.06	31.52	31.19	31.08	0.24	ns[2]
ADG, kg/d	0.95	0.97	0.98	0.98	0.99	0.01	ns
ADFI, kg/d	1.95	1.95	1.91	1.88	1.87	0.03	ns
FCE, gain:feed	0.49	0.50	0.52	0.52	0.53	0.01	L
Phase 2							
Wt, kg (day 0)	53.15	52.97	53.38	53.39	53.48	0.32	ns
ADG, kg/d	1.04	1.08	1.10	1.06	1.06	0.02	ns
ADFI, kg/d	2.74	2.72	2.74	2.51	2.51	0.04	ns
FCE, gain:feed	0.38	0.40	0.41	0.41	0.43	0.01	L
Phase 3							
Wt, kg (day 0)	80.10	79.47	80.30	80.16	80.22	0.44	ns
Wt, kg (end)	115.07	115.51	115.26	115.02	115.58	0.41	ns
ADG, kg/d	1.04	1.08	1.10	1.07	1.06	0.02	ns
ADFI, kg/d	3.29	3.19	3.20	3.05	2.94	0.05	ns
FCE, gain:feed	0.30	0.32	0.32	0.33	0.35	0.01	L
Overall							
ADG, kg/d	1.00	1.02	1.03	1.01	1.05	0.01	ns
ADFI, kg/d	2.76	2.69	2.67	2.59	2.49	0.03	L
FCE, gain:feed	0.36	0.38	0.38	0.39	0.42	0.01	L

[1]Refers to the energy concentration which was determined experimentally at the mid-point of each phase.

[2] ns; the response to dietary energy level was not linear ($P>0.05$), L; a significant response to dietary energy level was observed ($P < 0.05$).

Experimental Procedure

Five experimental treatments were employed : 3.1, 3.2, 3.3, 3.4 and 3.6 Mcal DE/kg. This range covers that which might be reasonably used in commercial practice, although both the lowest and highest DE values would be unusual. Diets were formulated to ensure that amino acids were not limiting the response to energy; barrows followed a separate feeding regime as compared to gilts, such that the digestible lysine:DE ratios were 2.80, 2.45 and 1.95 g/Mcal for barrows and 2.90, 2.55 and 2.05 g/Mcal for 25 to 50, 50 to 80 and 80 to 120 kg BW, respectively. Diet DE was constant within a treatment for the complete growout period. Diets were based on barley and soymeal and, depending on the energy level, incorporated varying amounts of wheat and canola oil.

[1] Prairie Swine Centre Inc., [2] PIC Franklin, Kentucky, USA

Results and Discussion

Energy density of the diet had no effect on ADG during any phase, or when calculated over the entire experimental period (Table 1). Feed intake declined as the energy density of the diet increased and feed efficiency was improved. Increasing the energy density of the diet resulted in a reduced lean yield and reduced backfat thickness (Table 2); surprisingly there was no effect on carcass value or on carcass premiums.

It is important to note that by commercial standards, pigs on this experiment exhibited a high feed intake and this could explain the lack of growth response to increases in dietary energy concentration. If feed intake had been lower, the response of the pigs to dietary energy concentration may have been different. A similar experiment is presently being conducted at a commercial farm to test this hypothesis.

Conclusion

In this trial, feeding lower energy, lower cost diets had no effect on ADG or on loin thickness, but did improve feed efficiency, and reduced backfat thickness. This indicates that lower energy diets may be used to increase net income. This experiment was conducted in an environment of high feed intake, and different results may accrue under conditions of lower feed intake. At the time of this trial, the lowest energy diet increased return over feed cost by more than $10 per pig sold, as compared to the highest energy diet.

Acknowledgements

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund. Support for this experiment from PIC is greatly appreciated.

"The lowest energy diet increased return over feed cost by more than $10 per pig sold."

Table 2. The effect of dietary energy density, gender and initial bodyweight on carcass value, days on test and feed cost over 3 phases of growth.

	Diet (Measured DE, Mcal/kg)						
Parameter	3.09	3.24	3.34	3.42	3.57	SEM	Reg.
Settlement Wt. (kg)	89.91	90.01	90.88	90.2	91.22	0.37	L
Index	113.81	112.91	113.45	111.70	113.24	0.48	ns
Yield	61.58	61.13	60.88	61.14	60.63	0.18	L
Fat, mm	16.83	17.79	18.33	18.62	19.39	0.34	ns
Lean, mm	61.65	60.55	62.72	60.25	61.06	1.06	ns
Price, $/pig	1.10	1.10	1.10	1.10	1.10	0.01	ns
Value, $/pig	111.36	111.63	111.67	110.20	112.75	1.16	ns
Premium, $/pig	5.56	5.33	5.53	5.06	5.00	0.18	L
Days on Test							
Phase 1	23.3	23.0	22.8	22.9	22.9	0.48	ns
Phase 2	25.9	24.8	24.6	25.0	25.0	0.49	ns
Phase 3	35.4	35.8	36.8	34.6	34.0	1.07	ns
Feed Cost, $/pig							
Phase 1	8.36	8.96	9.38	10.39	11.36	0.19	L
Phase 2	12.00	12.70	13.93	14.81	15.46	0.25	L
Phase 3	17.40	19.13	21.85	21.82	22.70	0.55	L
Total	37.76	40.76	45.16	47.03	49.52	0.61	L

[1] ns; the response to dietary energy level was not linear (P>0.05), L; a significant response to dietary energy level was observed (P < 0.05).

Interaction Among Lactose, Plasma Proteins and Crowding in Weanlings

A.D. Beaulieu[1], J.P. Patience[1], R.T. Zijlstra[1], M. Rivard[1], R. Musser[2],B. Lawrence[2], D. Overend[2], S. Hansen[2] and J. Boychuk[2]

Summary

The addition of 4 % plasma and 30 % lactose to the diets of weanling pigs modestly improved performance; however this effect was observed only during the initial 7 days post-weaning. There were no interactive effects of plasma with lactose, and the results were independent of starting weight. Crowding decreased performance by day 49 of the nursery period.

Introduction

Lactose and porcine plasma are two key ingredients in current starter programs that may become even more important if antibiotic use in the diet is restricted. Feed additives such as plasma and lactose could have differential effects depending on the weight or age of the pigs. Floor space allowance is always an important variable in pig production. This experiment was designed to 1) determine the interactive effects of plasma proteins and lactose on weanling pig performance when fed antibiotic-free diets 2) compare the response to lactose and plasma proteins in crowded and non-crowded pigs 3) determine the impact of weaning weight on the response to lactose and plasma proteins.

"The inclusion of plasma or lactose in the diet had no effect on performance over the entire experimental period."

Experimental Procedures

Pigs (n=360) were weaned at an average age of 17.5 days (BW = 5.75 kg) and assigned to one of 6 unmedicated treatment diets; 2 levels of plasma proteins (day 0 to 7, 2 or 4 %: day 8 to 21, 2 or 0 %) and 3 levels of lactose (day 0 to 7, 10, 20 or 30 %; day 8 to 21, 0, 10 or 20 %). From day 22 to 49 all pigs received a common, unmedicated starter diet. Pens (5.4 m^2) housed either 18 or 24 pigs, and pigs were blocked at day 0 on the basis of bodyweight.

Results and Discussion

Overall, the performance of the pigs in this trial was less relative to the performance typically observed in this barn, probably a reflection of the absence of antibiotics in the feed. The inclusion of plasma and/or lactose in the diet had no effect on performance over the entire experimental period (d0 to 49). However, there were interactions between plasma proteins and days, and lactose and days, indicating that an early response to these two products was observed, but this was not sustained through to the end of the nursery period. As expected, heavier pigs grew faster than lightweight pigs; interestingly, this effect was independent of diet. A detrimental effect on performance of increased numbers of pigs per pen (18 or 24 pigs per pen) was observed, but

Table 1. The effect of including plasma protein and / or lactose in the diet, and initial body weight on the performance of nursery pigs over two phases of growth.

	Plasma (%)			Lactose (%)				Initial Weight		
Phase	2/0[a]	4/2	SEM	10/0	20/10	30/20	SEM	Light	Heavy	SEM
ADG, kg/day										
d 0-22	0.22	0.25	0.01	0.24	0.24	0.23	0.01	0.21	0.26	0.01
d 23-49	0.59	0.58	0.01	0.60	0.57	0.59	0.01	0.55	0.63	0.01
ADFI, kg/day										
d 0-22	0.28	0.31	0.02	0.29	0.30	0.30	0.03	0.26	0.33	0.02
d 23-49	0.83	0.82	0.02	0.84	0.82	0.82	0.03	0.78	0.86	0.02
Feed Conversion, gain/feed										
d 0-22	0.79	0.80	0.02	0.82	0.79	0.78	0.02	0.80	0.79	0.02
d 23-49	0.73	0.72	0.02	0.73	0.71	0.73	0.02	0.71	0.74	0.02
Coefficient of Variability, (CV) %										
d 49	13.9	14.1	0.5	13.5	14.2	14.3	0.6	15.6	12.4	0.5

[a]Refers to the % in the diet, day 0-8/ day 9-22.

[1] Prairie Swine Centre Inc. [2] Ridley Inc., Mankato, MN. USA

Table 2. Economic analysis of including lactose and plasma proteins in the diet of nursery pigs

Treatments				
No.	Lactose[a]	Plasma[a]	Total Feed Cost, $[b]	Cost, kg gain[c]
1	30/20	4/2	15.58	0.724
2	20/10	4.2	14.28	0.667
3	10/0	4/2	14.00	0.638
4	30/20	2/0	14.28	0.682
5	20/10	2/0	13.96	0.657
6	10/0	2/0	13.64	0.616

[a]Refers to percent in the diet, day 0-8/day 9-22.
[b]Total cost of feed/pig for period indicated.
[c]Calculated on a per pig basis, therefore numbers of pigs removed/treatment has not been considered.

only during the final two weeks of the experiment (day 36 to 49).

The plasma and lactose increased the cost of these starter diets. Therefore, due to the lack of an overall effect of these ingredients on performance, the cost per kg of gain increased with their inclusion.

Conclusion

A modest improvement in performance during the initial 7 days post-weaning was observed with the addition of 4% plasma and 30 % lactose in the diet of weanling pigs. There were no interactive effects of plasma with lactose, and the results were independent of starting weight. Although not directly tested in this experiment, the performance of the pigs in this trial indicates that plasma protein and lactose dietary supplementation do not replace antibiotics in a nursery diet. Providing pigs with less than recommended floor space allowance will decrease performance. The detrimental effect of crowding becomes increasingly evident as the pigs grow.

Acknowledgement

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund. The authors would like to acknowledge the financial support provided for this experiment by Ridley, Inc.

"There were no interactive effects of plasma with lactose, and the results were independent of starting weight."

Crowding Reduces Performance of Weanling Pigs

J.P. Patience[1], H.W. Gonyou[1], A.D. Beaulieu[1], D. Gillis[1] and B. Lawrence[2]

Summary

The effect of floor space allowance on the performance of weanling pigs was examined by housing groups of 17 pigs in pens with a floor space of either 5.58 m^2 (uncrowded) or 4.00 m^2 (crowded). Crowding adversely affected growth and feed intake by week 4 post-weaning. These data support the current recommendations on floor space allowance for weanling pigs.

Introduction

Floor space allowance is an important variable in pig production. However, the effect of floor space on performance is often examined by using different group sizes within a constant floor space. This confounds the results because group size per se may affect performance as well as floor space. In this experiment, floor space allowance was examined using a constant group size of 17 pigs, but housed in pens of varying square footage. According to the Recommended Code of Practice, (Agriculture Canada, 1993), floor space allowance can be calculated using the formula, $A = k\ BW^{.67}$ where A = area in m^2 and BW is in kilograms. It is recommended that the coefficient, *k*, be 0.035 when fully slatted pens are used (ie. for a 20 kg pig, $A = 0.035\ (20)^{.67}$ or A = 0.26 m^2 per pig).

This experiment was part of a larger trial designed to examine the interaction of various dietary treatments and crowding on the growth and variability in growth of weanling pigs. There were no interactions, and only the main effects of the crowding are reported here.

"Crowding adversely affected growth and feed intake by week 4 post-weaning."

Experimental Procedures

A total of 816 weanling pigs were assigned to either a crowded or a noncrowded treatment. A false back wall was installed in the pens designated "crowded" to provide the

Table 1. The effect of reduced floor space allowance on the performance of weanling pigs.

	Uncrowded 17 pigs/pen	Crowded 17 pigs/pen	
Pen size	5.58 m^2	4.00 m^2	P value[a]
BW, kg			
d 0	5.64	5.64	-----
d 8	6.49	6.51	0.71
d 14	8.11	8.12	0.92
d 22	11.53	11.49	0.74
d 35	19.12	18.93	0.29
d 42	24.12	23.62	0.03
d 54	33.66	32.69	0.0004
ADG, kg/day			
d 0-8	0.107	0.109	0.68
d 9-14	0.256	0.262	0.51
d 15-22	0.428	0.421	0.52
d 23-28	0.485	0.480	0.73
d 29-35	0.658	0.647	0.34
d 36-42	0.714	0.671	0.003
d 43-54	0.795	0.748	0.0002
ADFI, kg/day			
d 0-8	0.133	0.138	0.26
d 9-14	0.313	0.312	0.98
d 15-22	0.521	0.529	0.49
d 23-28	0.641	0.624	0.09
d 29-35	0.861	0.838	0.04
d 36-42	1.083	1.0445	0.01
d 43-54	1.338	1.266	0.0001
Gain:Feed			
d 0-8	0.794	0.780	0.63
d 9-14	0.820	0.837	0.50
d 15-22	0.827	0.798	0.12
d 23-28	0.754	0.769	0.35
d 29-35	0.765	0.773	0.39
d 36-42	0.659	0.642	0.09
d 43-54	0.595	0.591	0.61
Total Feed Cost, $/pig			
d 0 – 54	12.91	12.71	0.20
Feed cost per kg of gain, $/kg			
d 0 - 54	0.457	0.464	0.09

[a]Initial weight was used as a covariate in the statistical analysis.

[1] Prairie Swine Centre Inc., Saskatoon, SK Canada. [2] Ridley Inc., Mankato, MN. USA

specified area of 0.23 m^2 per pig for the crowded treatment vs 0.35 m^2 per pig for the normal treatment (2.5 vs 3.75 ft^2/pig). Using the Agriculture Canada recommendation of 0.035 for *k,* pigs with a floor space allowance of 0.35 m^2 are "crowded" at a bodyweight of about 30 kg, while those with the reduced pen size will be crowded at a bodyweight of about 17 kg.

Results and Discussion

An effect of crowding on growth was evident by the 5th week of this experiment when ADG was reduced by about 40 grams per pig per day in the crowded treatment. At this point in the experiment, bodyweight in the crowded treatment was about 19 kg or just slightly above the 17 kg predicted by the Agriculture Canada formula. A reduced feed intake was observed by the 4th week of the experiment in the crowded pens, when the pigs weighed almost 12 kg. Neither feed efficiency nor the cost per kg of gain were affected by floor space allowance and there was no effect of crowding on the variability in growth (data not shown).

Conclusions

Housing pigs with less than the recommended floor space allowance will reduce growth and feed intake. The current recommendations for floor space of weanling pigs would appear to be correct.

Acknowledgements

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund. The authors would like to acknowledge the financial support provided for this experiment by Ridley, Inc.

"Current recommendations for floor space of weanling pigs would appear to be correct."

Nutritional Value of Zero-Tannin Faba Beans for Grower-Finisher Hogs

R.T Zijlstra [1], K. Lopetinsky [2], B. Dening [3], G.S. Bégin [4], and J.F. Patience [5]

Summary

Zero-tannin faba beans are a potential replacement of soybean meal in swine diets. The chemical characteristics, energy and amino acid (AA) digestibility, the content of DE and NE, and tannin content of zero-tannin faba beans were determined and indicate, together with the subsequent growth performance variables and carcass quality of grower-finisher pigs, that zero-tannin faba beans can replace soybean meal and result in similar performance in grower-finisher pigs.

"Zero-tannin faba beans can replace soybean meal and result in similar performance in grower-finisher pigs."

Introduction

Faba bean (Vicia faba minor) production is not new to Alberta. Research was completed in the early 1970's; however, tannin and other anti-nutritional factors limited the use faba beans in swine diets. Presently, zero-tannin faba bean varieties are available. The general purpose of this project was to remove barriers, which were preventing increased production and use of zero-tannin faba beans in Alberta, especially in the Parkland and Peace regions. Analysis of the nutrient content of zero-tannin faba beans and a subsequent performance study confirming equal performance were thus needed. Objectives were (1) to determine chemical characteristics, energy and amino acid (AA) digestibility, the content of DE and NE, and tannin content of zero-tannin faba beans; and (2) to compare growth performance variables and carcass quality of grower-finisher pigs fed zero-tannin faba beans to soybean meal.

Experimental Procedures

One sample of zero-tannin faba beans was collected in Alberta.

Exp. 1. Digestibility Study

Energy and amino acid digestibility was tested using cannulated 60-kg barrows. Energy digestibility was tested in a diet containing 96% faba beans. Amino acid digestibility was tested in a diet containing 62% faba beans and 35% corn starch. Diets were fed at 3 x maintenance. Faeces were collected for 2-d followed by 2-d collection of ileal digesta. Standardized AA, DE and NE contents were determined.

Exp. 2. Performance Study

100 grower-finisher pigs in 20 pens had free access to either a soybean meal or faba bean-based diet regime from 30 –115 kg. Diets were formulated to equal NE and SID (Grower (30-60 kg), 2.40/3.95; Finisher I (60-90 kg), gilts 2.38/3.15, barrows 2.38/2.76; Finisher II (90-115 kg), gilts 2.38/2.92, barrows 2.35/2.55; Mcal kg-1 NE/g SID lysine Mcal-1 NE, respectively), with up to 30% faba beans. Pigs were weighed, feed intake was measured, and carcass measurements were obtained.

Table 1. Characteristics of Zero-Tannin Faba Beans

Nutrient	% as Fed
Moisture	13.4
Crude Protein	27.5
ADF	9.6
NDF	19.8
Tannin	1.1
EE	1.0
Lysine	1.75
Threonine	0.88
Methionine	0.21
Total sulsphur AA	0.56
Trytophan	0.25

Table 2. Energy Profile of Zero-Tannin Faba Beans

Energy	As Fed
Ileal	
Digestibility (%)	60.2
DE content (kcal/kg)	2,362
Total Tract	
Digestibility (%)	88.5
DE content (kcal/kg)	3,471
NE content (kcal/kg)	2,267

Table 3. Amino Acid Profile of Zero-Tannin Faba Beans

Energy	% as Fed
Lysine	
App. Digestibility	85.9
SID	1.54
Threonine	
App. Digestibility	76.1
SID	0.70
Methionine	
App. Digestibility	74.1
SID	0.16
Tryptophan	
App. Digestibility	76.4
SID	0.20

[1] University of Alberta, Edmonton, AB, [2] Crop Development Centre North, Edmonton, AB; [3] Alberta Agriculture Food and Rural Development, Barrhead, AB; [4] Alberta Swine Diet Formulators Corp. Edmonton, AB. [5] Prairie Swine Centre Inc.

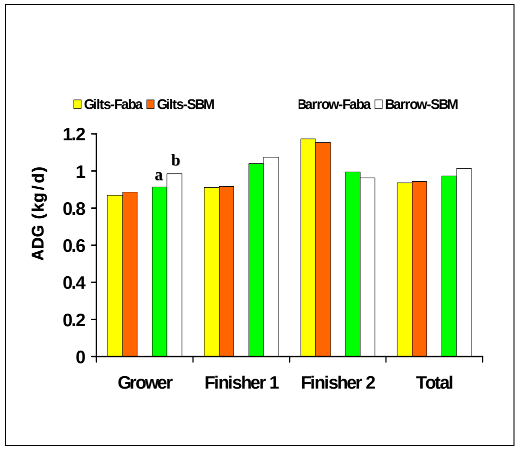


Figure 1. Average daily gain (ADG) of pigs fed zero-tannin faba beans or soybean meal

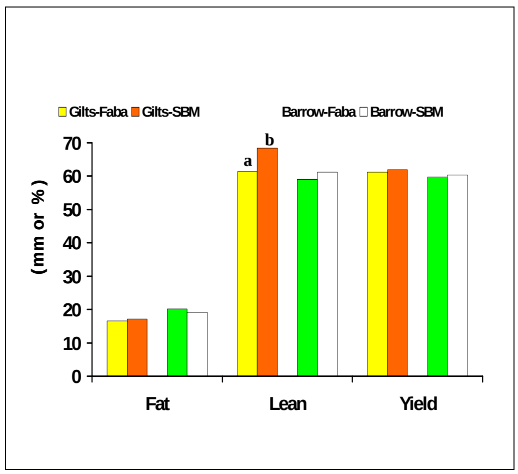


Figure 2. Carcass data of pigs fed zero-tannin faba beans or soybean meal

Results and Discussion

The chemical characteristics (Table 1) and energy (Table 2) and AA (Table 3) profiles suggest that zero-tannin faba beans have a desirable nutrient content (slightly better than peas; NRC 1998). Overall, ADG (Figure 1) and ADFI (data not shown) did not differ between zero-tannin faba beans or soybean meal (P > 0.10) suggesting that faba bean inclusion up to 30% might be possible without reducing ADG. The higher ADG for barrows during the Grower phase and higher lean depth for gilts fed soybean meal compared to zero-tannin faba beans (Figure 2) suggest that the available energy content needs further investigation.

"Overall, ADG and ADFI did not differ between zero-tannin faba beans or soybean meal."

Conclusion

In conclusion, the zero-tannin faba bean is a worthwhile protein ingredient to consider as a replacement for soybean meal.

Acknowledgements

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Xylanase and Phytase Supplementation on Growth Performance of Grower Pigs

T.N. Nortey[1,2], J.F. Patience[1], P.H. Simmins[3], and R.T. Zijlstra[4]

Summary

The nutritional value of wheat millrun with xylanase and (or) phytase supplementation in wheat based diets for growing pigs was evaluated. Wheat millrun inclusion depressed energy and P digestibility and also ADG, but had not effect on ADFI and G:F. Xylanase and phytase reduced ADFI and improved nutrient digestibility. However, the improved nutrient digestibility did not result in improved growth performance.

Introduction

Feed cost might be reduced or nutrient intake might be enhanced if nutrients bound by the arabinoxylan and phytate of wheat millrun could be released through enzyme supplementation to a higher extent. This would allow for large inclusion rates of wheat millrun into swine diets, while maintaining growth performance. An increased energy and amino acid digestibility in the small intestine is especially beneficial to the pig, but increased energy digestibility in the large intestine will also be beneficial to improve the energy status. Improved utilization of dietary phosphorus will be beneficial economically, but will also reduce the pressure of swine production on the environment.

"Wheat millrun inclusion depressed energy and P digestibility and also ADG."

Table 1. Ingredient and Nutrient Composition Data

Ingredient (%)	Wheat	20% Wheat millrun[z]	40% Wheat millrun[z]
Wheat	83.26	61.83	40.26
Wheat millrun	-	20.00	40.00
Soybean meal	12.50	12.50	12.50
Canola oil	-	1.80	3.60
Dicalcium phosphate	1.20	0.70	0.40
Limestone	0.85	1.00	1.10
L-lysine HCl	0.49	0.47	0.45
Vitamin premix[y]	0.50	0.50	0.50
Mineral premix[w]	0.50	0.50	0.50
Sodium bicarbonate	0.29	0.29	0.29
Salt	0.20	0.20	0.20
L-Threonine	0.15	0.14	0.13
DL-Methionine	0.06	0.07	0.07
Calculated nutrient content			
DE (Mcal kg^{-1})	3.34	3.34	3.34
Dig. Lysine (g $Mcal^{-1}$ DE)[v]	2.80	2.80	2.80
Calcium	0.70	0.70	0.70
Total phosphorus	0.60	0.60	0.63

[Z] Xylanase was included at a rate of 167 g $Tonne^{-1}$ of finished feed and phytase at a rate of 100 g $Tonne^{-1}$ of finished feed.

[Y] Provided per kilogram of premix: vitamin A, 1 650 000 IU; vitamin D_3, 165 000 IU; vitamin E, 8000 IU; niacin, 7 g; D-pantothenic acid, 3 g; riboflavin, 1g; menadione, 800 mg. folic acid, 400 mg; thiamine, 200 mg; D-biotin; 40 mg; vitamin B_{12}, 5 mg

[W] Provided per kilogram of premix: Zn, 20 g; Fe, 16 g; Cu, 10 g; Mn, 5 g; I, 100 mg; Se, 20 mg.

[V] Contained by calculation 2.80 apparent digestible lysine $Mcal^{-1}$ DE (0.94% apparent digestible lysine) and an ideal pattern of digestible amino acids compared to lysine (%); lysine 100; threonine 60; methionine 30 (NRC 1998).

Experimental Procedure

Digestibility study: Eight diets based on wheat and either 20 or 40% wheat millrun without enzyme, or with xylanase and (or) phytase (Table 1) were tested in a 2 x 2 x 2 factorial arrangement together with a wheat control diet in 3 separate periods in 18 cannulated pigs, according to a three-period change over design for a total 54 observations of six observations per diet.

Performance Study: 72 pigs (PIC, initial BW 30 kg) were fed one of the nine experimental diets each for 35 days. The experimental diets were fed in one period in eight blocks (four barrow for gilts), for a total of 72 observations or eight observations per diet. Average daily gain, ADFI, and feed efficiency were determined on a weekly basis.

Results and Discussion

Ileal and total tract energy digestibility was affected by millrun inclusion, xylanase and phytase addition. Millrun addition reduced P digestibility linearly and phytase and xylanase supplementation improved P digestibility. In contrast to digestibility data, performance data were less conclusive. Millrun inclusion reduced ADG linearly, but did not affect ADFI or G:F. Xylanase and phytase reduced ADFI, and phytase tended to reduce ADG . Enzyme supplementation did not affect final BW or G:F.

[1] Prairie Swine Centre Inc.. [2] University of Saskatchewan, Saskatoon, SK. [3] Danisco Animal Nutrition, Marlborough, UK. [4] University of Alberta, Edmonton, AB.

Table 2. Effect of wheat millrun inclusion level and enzyme supplementation on ileal and total-tract energy and DM digestibility and DE content of diets fed to grower pigs

	Millrun (%)								
	0	20				40			
Variable	Control	Control	Xylanase	Phytase	X+P	Control	Xylanase	Phytase	X+P
Ileal									
Energy digestibility (%)	77.5^{a}	68.1^{bcd}	72.4^{b}	71.6^{bc}	72.5^{b}	62.0^{e}	68.1^{bcd}	67.4^{cd}	66.6^{d}
DE (kcal kg^{-1} DM)	3416^{a}	3097^{b}	3292^{ab}	3262^{ab}	3318^{ab}	2896^{c}	3199^{ab}	3141^{b}	3129^{b}
DM digestibility (%)	79.4^{a}	69.9^{c}	73.9^{b}	73.8^{b}	74.2^{b}	63.4^{d}	69.2^{c}	68.7^{c}	67.9^{c}
Total-tract									
Energy digestibility (%)	84.4^{a}	77.6^{c}	79.8^{b}	78.9^{bc}	80.7^{b}	71.5^{f}	75.5^{d}	73.4^{e}	73.1^{e}
DE (Kcal kg^{-1} DM)	3720^{a}	3528^{d}	3632^{bc}	3596^{cd}	3692^{ab}	3337^{f}	3548^{cd}	3424^{e}	3433^{e}
DM digestibility (%)	86.7^{a}	80.3^{c}	82.2^{b}	81.7^{b}	83.1^{b}	74.2^{f}	77.9^{d}	76.1^{e}	75.9^{e}
Total-tract minus ileum									
Energy digestibility (%)	6.9	9.5	7.5	7.3	8.2	9.4	7.6	6.1	6.5
DE (kcal kg^{-1} DM)	304	430	340	334	374	441	359	282	303

NS: Not significant
[Abcd] Means within the same row with the same letter are not different P>0.05.
y:: Linear and quadratic responses were analyzed using 0%, 20%, and 40% control diets.
[z] Source of variation and probability only among diets that contain millrun and/or enzyme.
Xyl: Xylanase.
Phy: Phytase.

Table 3. Effect of millrun and enzymes on performance of grower pigs over time

	Millrun (%)								
	0	20				40			
Age	Control	Control	Xylanase	Phytase	X+P	Control	Xylanase	Phytase	X+P
Average daily feed intake (kg d^{-1})									
0-35	2.6^{a}	2.6^{a}	2.4^{bc}	2.4^{bc}	2.3^{c}	2.5^{ab}	2.4^{bc}	2.4^{bc}	2.3^{c}
Average daily gain (kg d^{-1})									
0-35	1.05^{a}	0.98^{a}	0.99^{a}	0.92^{b}	0.95^{b}	0.94^{b}	0.91^{b}	0.93^{b}	0.92^{b}
Feed efficiency									
0-35	0.41	0.39	0.42	0.39	0.42	0.41	0.39	0.39	0.41
Final body weight (kg)									
d 35	76.8^{a}	70.3^{b}	70.1^{b}	67.5^{c}	68.7^{b}	68.5^{b}	67.5^{c}	68.3^{b}	67.7^{c}

NS: Not significant
[Abcd] Means within the same row with the same letter are not different P>0.05.

Conclusions

Overall, millrun inclusion reduced nutrient digestibility and growth performance. Xylanase and phytase improved nutrient digestibility; however, the improved digestibility did not result in improved growth performance, perhaps indicative of a nutrient imbalance.

Acknowledgements

Program funding was provided by Sask Pork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund. Danisco Animal Nutrition funded the project.

"Xylanase and phytase improved nutrient digestibility; however, the improved digestibility did not result in improved growth performance."

Nutritional Value of Corn and Wheat Distillers Grain and Growth Performance

G. P. Widyaratne[1,2] and R. T. Zijlstra[3]

Summary

Nutritional value of corn, wheat+corn (4:1) and wheat distiller's dried grains with solubles (DDGS) for grower-finisher pigs was evaluated. Corn DDGS had the highest digestible energy (DE) and ileal digestible lysine contents but the digestible phosphorus (P) content was similar among DDGS samples. Following characterisation of its digestible nutrient profile, DDGS still resulted in reductions in growth performance, suggesting that either the reduced average daily feed intake (ADFI) or other nutritional factors for DDGS deserve further investigation to ensure a successful implementation of DDGS in swine diets.

Introduction

DDGS is primarily a by-product from the cereal grain-based ethanol industry. With the growth of the ethanol industry, increasing quantities of DDGS are available for livestock rations. However, the potential of DDGS in swine industry is not fully realized because of the scarcity of information on its nutritional value for swine. In general, DDGS has higher concentrations of nutrients such as protein, fat, vitamins, minerals, and fibre than its parent grain. These nutrients are concentrated due to the removal of most of the cereal starch as ethanol and carbon dioxide during the fermentation process.

Wheat and corn DDGS are potential feed ingredients for the swine industry, although DDGS is presently not an important ingredient in western Canada.

"Results indicate that the complex carbohydrate profile appears to be a major constraint to the nutritional value of DDGS "

Experimental Procedure

Digestibility Study: Digestibility and digestible contents of energy, amino acid (AA) and P in DDGS were determined, using 12 barrows fitted with ileal T-cannulae. Pigs were fed a wheat-based control diet or one of three diets with 40% corn, wheat+corn or wheat DDGS in two periods in a controlled cross-over design. Diets were fed twice daily at 2.6 x maintenance.

Table 1. Chemical characteristics of wheat, and corn, wheat + corn, and wheat distiller's dried grains with solubles (% DM)

		Distiller's Dried Grains with Solubles		
Variable	Wheat	Corn	Wheat+corn	Wheat
Moisture	11.8	11.8	8.0	8.1
Crude protein	19.8	30.3	42.4	44.5
Non-protein nitrogen	4.6	5.4	12.4	10.2
Crude fat	1.8	12.8	4.7	2.9
Ash	2.1	4.8	5.0	5.3
Phytate	1.4	0.9	0.6	0.8
Phosphorus	0.5	1.0	1.1	1.2
Acid detergent fibre	2.7	14.6	19.5	21.1
Neutral detergent fibre	9.4	31.2	30.6	30.3
Crude fibre	2.4	7.0	7.8	7.6
Amino acid				
Arginine	0.91	1.33	1.64	1.77
Cysteine	0.48	0.70	0.89	0.96
Histidine	0.46	0.82	0.95	0.99
Isoleucine	0.68	1.14	1.50	1.59
Leucine	1.31	3.52	3.13	3.01
Lysine	0.52	0.83	0.72	0.72
Methionine	0.32	0.61	0.67	0.69
Phenylalanine	0.96	1.51	1.98	2.16
Threonine	0.54	1.09	1.22	1.28
Tryptophan	0.23	0.23	0.37	0.44
Valine	0.84	1.53	1.83	1.91
Total	19.48	28.32	37.25	40.21

Table 2. Apparent ileal and total tract digestible energy (kcal kg^{-1} DM), apparent and standardized ileal digestible lysine (% DM) and total tract digestible phosphorus (% DM) contents in wheat, and corn, wheat + corn, and wheat distiller's dried grains with solubles

	Wheat	Distiller's Dried Grains with Solubles			Pooled
Variable	Control	Corn	Wheat+corn	Wheat	SEM [z]
Energy					
Ileal [y]	3224[b]	3671[a]	3495[ab]	3406[ab]	82.1
Total tract [y]	3807[b]	4292[a]	4038[b]	4019[b]	73.4
Lysine					
Apparent ileal [y]	0.37[c]	0.51[a]	0.45[b]	0.42[b]	0.02
Standardized ileal [y]	0.41[c]	0.55[a]	0.49[b]	0.46[b]	0.02
Phosphorus [y]	0.08[b]	0.47[a]	0.56[a]	0.55[a]	0.04

[Z] Standard error of means. [Y] Wheat differs from the three DDGS ($P < 0.05$).
[a-d] Within a row, means without a common letter differ ($P < 0.05$).

[1] Prairie Swine Centre Inc. [2] University of Saskatchewan, Saskatoon, SK, [3] University of Alberta, Edmonton, AB

After a 6-d acclimation, faeces was collected for 3 d, and ileal digesta for 2 d.

Performance Study: A total of 100 grower pigs in 20 pens were fed a wheat-pea control diet or one of three diets with 25% corn, wheat+corn or wheat DDGS for 5 wk. Average daily gain (ADG), ADFI, and feed efficiency (G:F) were determined on weekly basis, for a total of five observations per diet.

Results and Discussion

The chemical and nutritional properties varied among the three DDGS samples. Despite the equivalent or higher total nutrient content, nutrient digestibility was lower for the DDGS than the wheat, except for P, which had a digestibility higher for DDGS than wheat. Nevertheless, the digestible contents of nutrients of interest were higher for DDGS than for the wheat. Finally, DDGS inclusion reduced growth performance of pigs, without affecting feed efficiency.

Conclusion

Overall, the results of this study indicate that the complex carbohydrate profile appears to be a major constraint to the nutritional value of DDGS for pigs due to its influence on feed intake, retention time, and the digestion of energy and other nutrients. Further, the nutritional value of DDGS might be enhanced by improving the AA balance through supplementation with limiting AA like lysine, in synthetic form and concomitant reduction of high fiber level with supplementary enzymes.

Acknowledgements

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Table 3. Growth performance of pigs fed diets containing wheat, or corn, wheat+corn, and wheat distiller's dried grains with solubles

Variable	Wheat control	Distiller's Dried Grains with Solubles			Pooled SEM
		Corn	Wheat+corn	Wheat	
Body weight (kg)					
d 7	60.19	59.58	59.04	59.45	0.44
d 14	67.01	65.99	65.83	65.78	0.44
d 21	74.33	72.30	72.22	72.33	0.44
d 28	81.31^{a}	78.89^{ab}	78.77^{b}	78.89^{ab}	0.44
d 35^{y}	88.06^{a}	85.82^{ab}	85.39^{b}	85.70^{ab}	0.44
ADG (kg d^{-1})					
d 0 to 7	1.136	1.056	1.011	1.024	0.03
d 8 to 14	0.982	0.922	0.959	0.920	0.03
d 15 to 21	1.056	0.906	0.899	0.950	0.03
d 22 to 28	1.004	0.950	0.923	0.948	0.03
d 29 to 35	0.972	0.996	0.933	0.990	0.03
d 0 to 35^{y}	1.030^{a}	0.966^{ab}	0.945^{b}	0.967^{ab}	0.03
ADFI (kg d^{-1})					
d 0 to 7	2.455	2.294	2.212	2.309	0.05
d 8 to 14	2.723	2.608	2.558	2.475	0.05
d 15 to 21	2.823	2.618	2.676	2.687	0.05
d 22 to 28	2.943^{a}	2.802^{ab}	2.664^{b}	2.863^{ab}	0.05
d 29 to 35	2.973	2.880	2.928	2.925	0.05
d 0 to 35^{y}	2.784^{a}	2.640^{b}	2.607^{b}	2.651^{b}	0.05
Feed efficiency					
d 0 to 7	0.462	0.460	0.358	0.445	0.01
d 8 to 14	0.362	0.355	0.375	0.377	0.01
d 15 to 21	0.376	0.347	0.335	0.355	0.01
d 22 to 28	0.340	0.341	0.360	0.332	0.01
d 29 to 35	0.328	0.349	0.320	0.342	0.01
d 0 to 35	0.373	0.371	0.370	0.370	0.01

^{z} Standard error of means. ^{y} Wheat differs from the three DDGS ($P < 0.05$). $^{a\text{-}b}$ Within a row, means without a common letter differ ($P < 0.05$).

Effect of Wheat Quality and Xylanase Supplementation on Weaned Pigs

R.T. Zijlstra[1], D. Overend[2], M. Schalm[3], A. Owusu-Asiedu[1], P.H. Simmins[4] and J.F. Patience[1]

"Xylanase enzyme supplementation partially reduced the variation in performance of weaned pigs caused by wheat sample."

Summary

The feed processing procedure xylanase supplementation was tested to reduce the existing variability in wheat quality. Xylanase enzyme supplementation partially reduced the variation in performance of weaned pigs caused by wheat sample.

Introduction

Nutritional quality between wheat samples is influenced by protein and fiber content. Supplementation with a fiber-degrading enzyme may reduce the impact of wheat quality variance on pig performance.

Experimental Procedures

Six wheat samples representing a wide range in neutral detergent fibre (20.1 to 35.7% dry matter) and narrow range in crude protein (18.8 to 21.4% dry matter) were collected. Effects of wheat samples and enzyme treatments (control; Trichoderma xylanase, 2625 U/kg diet) on performance were investigated in a 6 x 2 factorial arrangement in 12 diets. Diets (3.5 Mcal DE/kg and 3.4 g digestible lysine/Mcal DE) contained 65% wheat, 27% soybean meal, 2.1% canola oil, and 1.3% fishmeal as main ingredients. Diets were pelleted at 72 °C resulting in a pellet durability index ranging from 93 to 95. A 3-week growth study was conducted with 12-kg weaned pigs (PIC; 39-d-old; 4 pigs/pen, 12 pens per diet).

Results and Discussion

For d 0 to 7, wheat affected average daily gain and feed efficiency. Enzyme improved average daily gain and feed efficiency. However, wheat and enzyme interacted, because pigs responded positively to enzyme for five wheat samples (+0.26 kg at d 7) and negatively for one wheat sample (-0.30 kg). Wheat and enzyme did not affect ADFI, see Figure 1.

For d 8 to 14, average daily gain and feed efficiency were not affected by wheat or enzyme but average daily feed intake was affected by a wheat x enzyme interaction, producing 0.36 kg heavier pigs from enzyme-supplemented diets.

For d 15 to 21, average daily gain and feed intake were not affected by wheat or enzyme and wheat sample affected feed efficiency.

Overall for d 0 to 21, average daily gain was not affected by wheat or enzyme, average daily feed intake was affected by a wheat x enzyme interaction, and feed efficiency was affected by wheat sample and improved 2% by enzyme, resulting overall in 27-kg pigs.

Conclusion

In summary, wheat quality affects performance of weaned pigs and specific wheat samples may affect the response by pigs to enzyme supplementation. Wheat quality should be analyzed prior to diet formulation and processing to achieve a predictable performance.

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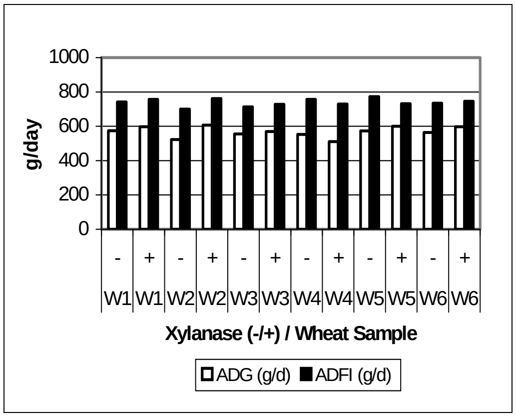

Figure 1. Effect of wheat sample and xylanase supplementation on average daily gain and feed intake for day 0 to 7

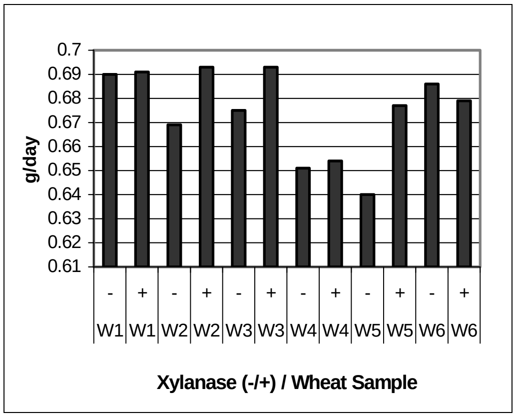

Figure 2. Effect of wheat sample and xylanase supplementation on feed efficiency (gain/feed) for day 0 to 21

[1] Prairie Swine Centre Inc. [2] Ridley Inc., Mankato, MN, [3] FeedRite, Lacombe, AB, [4] Danisco Animal Nutrition, Marlborough, UK.

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