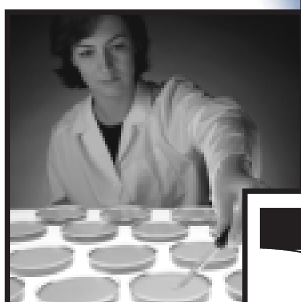
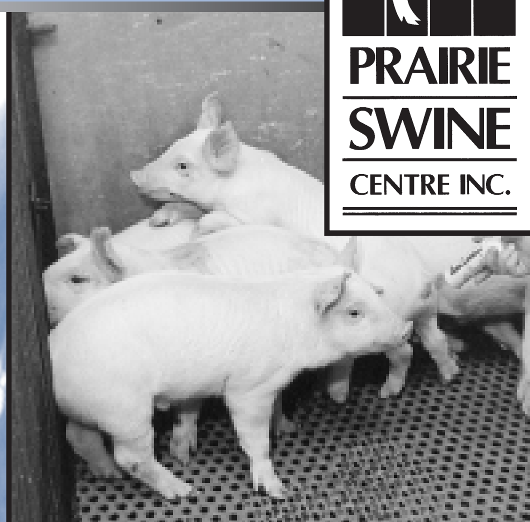


2000 ANNUAL RESEARCH REPORT

PRAIRIE SWINE CENTRE INC.



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Stay in touch with Prairie Swine Centre all year at http://www.prairieswine.com

GLOSSARY

A guide to some of the acronyms and terms in this publication

ADF	a fibre fraction used to identify characteristics of feed stuff.
ADFI	average daily feed intake.
ADG	average daily gain.
ad libitum	"at one's pleasure". In the context of feeders, a set up that allows the pigs access to feed as they want it.ammonium NH_4, a nitrogen compound found in commercial fertilizers and manure.
ß-glucanase	beta glucanase; an enzyme that breaks down beta glucans, a type of carbohydrate.
cannulated	to insert a small flexible tube into the small intestine to measure ingredient absorption.
carbohydrase	a class of enzyme used in digestion.
conceptus	the embryo and associated membranes of highly developed animals. In the context of this report, the developing piglets and supporting tissues.
CP	crude protein.
DE	dietary energy.
DM	dry matter.
digesta	digested feed.
distal	situated away from the point of origin or attachment. In case of the ileum, the last part of the small intestine.
EMS	earthern manure storage.
endotoxin	toxin produced by certain bacteria and released upon destruction of bacteria cell.
GE	gross energy.
H_2S	hydrogen sulfide. A colourless, poisonous gas that produces a "rotten egg" odour. In pig barns it is produced by the breakdown of manure and is extremely hazardous if not managed properly.
hedonic tone	subjective measure to the pleasantness or unpleasantness of odour.
ileal	pertaining to the latter part of the small intestine, or ileum. Nutrients from feed are absorbed in this area.
in situ	situated in its natural or existing place, i.e. barn vs. laboratory.
ILOs	intensive livestock operation.
kcal	kilocalorie, or one thousand calories. A calorie is the amount of energy required to raise one gram of water one degree.
lignin	organic substance which acts as a binder for cellulose fibre in wood and certain plants and adds strength and stiffness to cell walls.
lipid	a broad class of organic products found in living systems. They include fats, oils and fatty acids.
lysine	an amino acid essential for growth. Cereal grains are generally poor in lysine.
K	potassium.
micronization	processing of food and feed using infrared light. The process can increase the availability of nutrients.
N	nitrogen (N_2), a major component of the atmosphere and an essential plant nutrient.
NDF	neutral detergent fiber. One fraction of total fibre found in a feedstuff.

GLOSSARY

NH_3	ammonia, a nitrogen compound found in household cleaners, commercial fertilizers and manure. Evaporates easily at relatively low temperatures.
NIS	near infrared spectroscopy. Uses light to determine chemical compositon of a sample.
nitrate	NO_3, a nitrogen compound found in manure.
P	phosphorus.
phytate	a plant substance, common in cereal grains, that interferes with nutrient absorbtion.
regression	a standard statistical tool for comparing the relative behaviour of two or more variables. analysis
piezometer	an instrument used to measure fluid pressure or compressibility of a substance.
solute	a substance dissolved in a solution.
urea	principal end product of nitrogen metabolism in mammals.
xylanase	an enzyme which breaks down xylans, a type of carbohydrate.

CHALLENGE AND OPPORTUNITY

Wayne Vermette [1]
Chairman of the Board

Our industry has once again proven to be one of challenge, opportunity and prosperity. After the hog market crash of 1998 – 99 we were faced with the challenge of fine tuning our management, the opportunity to improve our production both in productivity as well as costs, and the opportunity to reap the prosperity that the market delivered in 2000.

When I reflect on the role Prairie Swine Centre Inc. has played as a research organization in the pig industry, it's obvious to me that the needs of the industry and concerns of the public at large have been accurately addressed in the following areas:

a) The continuous effort placed on reducing the cost of producing a kilogram of pork with focus on the use of alternate feed ingredients and reestablishing basic nutrient requirements.

b) Addressing animal welfare and behavior issues with ongoing research and some facility changes like the introduction of group sow housing at our Elstow facility.

c) By measuring the ongoing effect of ILOs and EMSs on our environment, with the use of elaborate monitoring equipment and an extensive monitoring program.

d) By providing management training to existing and potential managers as well as specialized courses such as H_2S awareness training.

On March 28 and 29, 2000 we proudly opened the doors, of PSC Elstow Research Farm Inc. to the public at a very well attended open house. The support shown by the public was a further affirmation of PSC commitment and direction taken for the pig industry. This 600 sow commercial-like barn is now in full production with leading edge research projects well under way.

Financial support by producers for the Prairie Swine Centre Inc. is of utmost importance and every producer dollar committed to the center is matched by seven outside research dollars. This year was a time for recommitment by the three Prairie provinces and we're very pleased that all three provincial producer organizations renewed a multi-year commitment. I commend the representatives of these organizations for their vision and commitment to the center.

One of Prairie Swine Centre's major research funding organizations, the Saskatchewan Agricultural Development Fund, conducted a five-year review of the Centre's activities. Representatives from all areas of our industry including government, University of Saskatchewan, feed sector and producers were questioned about the relevance and effectiveness of the Centre's activities. The review resulted in an overwhelming endorsement from all present. A decision on renewal funding is pending.

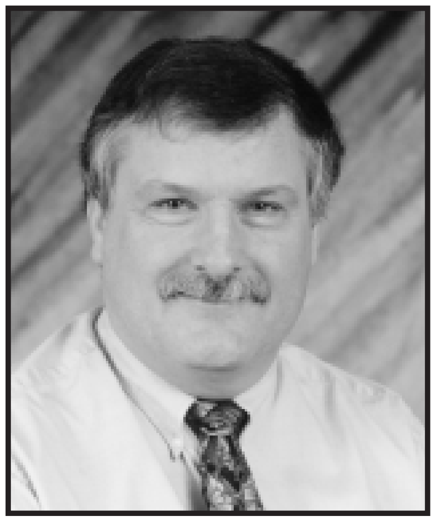
Through the concentrated efforts and dedication of PSC's management and staff, this organization continues to maintain its well earned status as a world class research organization. It is a pleasure for this Board of Directors to be able to work with this outstanding group of professional and dedicated people.

[1] Wayne Vermette is a pork producer who farms with his wife Maryann near Outlook, SK. Wayne has been a director with Prairie Swine Centre for five years.

BUILDING AN EFFICIENT, RESPONSIBLE INDUSTRY

Dr. John Patience
President

If there is one feature that has historically described our industry, it has been a constant desire for improvement. Since the 1920s, when the first national grading system was introduced, we have seen continuous adoption of new techniques in nutrition, engineering, reproduction, herd health and management, all with the goal of producing better pork at less cost. Canada's pork producers have been rewarded for their efforts. They are now the largest exporters of pork in the world, having overtaken countries that in previous years were viewed by Canadians with awe. As we enter the new millennium, that same desire for improvement continues. It is one feature of our industry that keeps me enthusiastic about what I do, and that every year attracts some of agriculture's best and brightest young people.



Today, the need to produce better pork at less cost is no less important, but new technical challenges are emerging. Society is scrutinizing what we do and how we do it with greater intensity than ever before. Animal welfare and the environment are two issues that are growing in profile and will have a greater impact on how we raise pigs in the future than they have in the past. As a research institution, we have the responsibility of responding to these emerging issues with new information, to answer new questions, review old ideas and to seek solutions that are financially viable and socially acceptable.

Dr. Harold Gonyou's team of applied ethologists are addressing such issues as floor space requirements, optimal group size, improved feeder design and dry sow housing alternatives. Dr. Lemay and his team of agricultural engineers are evaluating manure pit additives, ammonia control, green house gases and odour and dust control. Even nutritionists are refocusing, as Dr. Zijlstra and the nutrition team investigate dietary ways to reduce nitrogen and phosphorus emissions in the slurry. Multidisciplinary projects are addressing water conservation, young pig management and environmental management. While the Prairie Swine Centre cannot solve these problems, we can provide information that the pork industry can use to make important decisions about its future.

In the midst of these new challenges, we must not forget that as an export-oriented industry, we must maintain our competitive advantages. Thus, research on economic efficiency must be maintained, even as many external forces would have us redirect all of our resources to sustainability issues. As important as this may be, our future depends on remaining financially viable as well as sustainable in an increasingly critical world. The pressure to ignore efficiency research is growing, as public pressure on animal welfare and the environment intensifies. However, we see examples of nations around the world that forgot the importance of economic competitiveness; their role in pork production is rapidly declining. With input from the pork industry, the Prairie Swine Centre works to achieve balance in what we do, and not waver among the changing winds of political and technical issues.

In sum, research is not an end unto itself, but a means to an end, and that end is an efficient, sustainable pork industry now and in the future. It requires that researchers work closely with the industry to address public concerns and seek change based on science, not emotion. The Centre enjoys a close working relationship with pork producers and their representative agencies. We consider this one of our most valuable assets in developing effective research, technology transfer and education programs. The financial support of the pork industry, as well as the counsel and guidance that we receive from the industry, is invaluable to us.

I would like to take this opportunity to thank the Saskatchewan Department of Agriculture and Food for their financial support of PSC Elstow Research Farm, officially opened in March and populated with bred gilts in April. This new 600 sow farrow-to-finish unit provides unique research capabilites, including both group-housed and stall-housed dry sows, six partial-and eight fully-slatted growout rooms, side-wall and chimney-style exhaust fans, and two growout pens that allow for the collection of manure on a pen-by-pen basis. These and other features provide the Centre with truly world-class research facilities. The off-site nursery and growout rooms allow us to study single-versus multiple-site production, as well as bring in animals with a different genetic or health background for specific experiments. A new feed mill, to be constructed in 2001, will further add to our research capability. These new facilities will provide a tremendous boost to the research and teaching capability, not only of the Centre, but also to the students in agriculture, veterinary medicine and engineering at the University of Saskatchewan.

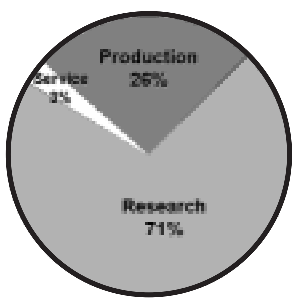
To make this all happen, we depend on people. This includes our staff and students, now numbering close to 50, who care for the pigs and conduct the research and implement our technology transfer and education programs. Without their dedication, Prairie Swine Centre would be a very different place than it is today. This also applies to our Board of Directors who on a voluntary basis provide direction and counsel and oversee a growing and increasingly complex organisation. I would like to take this opportunity to thank both groups for their commitment and dedication.

Prairie Swine Centre Team:
br: Eduardo Beltranena, Lee Whittington, Ruurd Zijlstra, Claude Laguë, Harold Gonyou
fr: Brian Andries, John Patience, Linda Ball, Stéphane Lemay

THE COST OF DOING BUSINESS

Prairie Swine Centre Inc. is a non-profit corporation. It derives its income from three different sources, the typical profile of which appears below. About one quarter of our revenue is derived from the sale of stock. While the function of the Centre is to conduct research, from an operational efficiency perspective, it is important that revenues from the sale of stock are maximized. This helps to keep the cost of research as low as possible and also ensures that the research is conducted in an environment typical of a well-run commercial farm. The goal of production is to operate within the top 10% of commercial herds as defined by the PigChamp database. Last year, the herd weaned 24.7 pigs per sow.

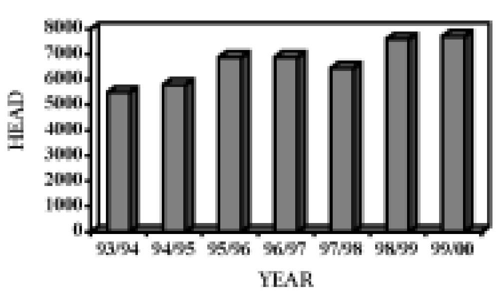
Typical Revenue Profile



However, research activity is not compromised by our desire to achieve a high level of herd productivity; no experiment is rejected because it might reduce herd productivity. Losses due to research are considered part of the "cost of doing business."

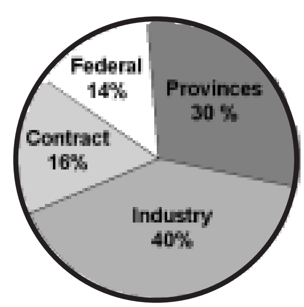
A small portion of the Centre's revenues (3%) are derived from a service contract with the College of Agriculture at the University of Saskatchewan to assure access by its students to the facility for teaching and research purposes.

Annual Animal Production



The largest proportion of revenues (71%) accrue from research agreements with various public and private agencies and organizations. About 45% of these agreements are with government agencies, such as the Saskatchewan Agriculture Development Fund (ADF), the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Alberta Agriculture Research Institute (AARI). Another 40% is derived from private organizations supporting public research at the Centre. This includes the pork producers of Saskatchewan (Sask Pork), Alberta (Alberta Pork) and Manitoba (Manitoba Pork Council) as well as the Canadian Pork Council, various grain commodity groups (eg. Canola Council of Canada, etc.) and other companies affiliated with the pork industry (eg. Pig Improvement Company, Degussa Hüls, Rhone Poulenc Canada, etc). Another 16% of revenues are derived by the Centre's contract research program, which provides confidential research services to private and public organizations; the Centre's list of clients in this area represents three continents and more than a dozen companies. In total, more than three dozen organizations, corporations and agencies support the research and technology transfer activities at the Prairie Swine Centre.

Research Reviews



NEW GENETICS AND AN IMPROVED ENVIRONMENT FOR RESEARCH PIGS

Brian Andries, B.Sc.
Manager-Operations

Production for this fiscal year, 1999/00, was above target on production parameters such as number farrowed, number born alive, numbers weaned and sold. We also surpassed performance levels achieved from the previous fiscal years.

Performance in the grow-finish area was slightly affected this year from overcrowding conditions that resulted from housing nearly 500 mature, bred females at PSCI, that were transported to PSC Elstow in April and May of 2000. These females were used to stock the new 600-sow facility at Elstow. Contract finishing market animals allowed us the opportunity to house these extra, bred gilts to alleviate space restrictions at PSCI. Also, this last year, a large number of weaner and grower pigs were sold to various departments within the University of Saskatchewan using swine for research projects.

Table 1. Production parameters for the 97/98, 98/99, and 1999/2000 fiscal years

	97/98	98/99	99/00
Sows farrowed, #	698	784	781
Farrowing rate, %	90.8	87.4	91.2
Pigs born alive/litter	10.8	11.0	11.2
Litters weaned	686	776	797
Pigs weaned	6615	7767	8033
Weaned/female inventory	23.9	24.2	24.5

Working with Pig Improvement Canada Ltd., we are currently in the process of replacing our F1 females with the C-22 female line, as well as changing our terminal sire line to a Line-65 Boar. The majority of Caesarean sections have been completed over the last year ensuring the proper number of “Grandparent” stock required to provide these two lines for Prairie Swine Centre Inc. and PSC Elstow. Conversion of stock at both facilities will be completed in fiscal years 2002/03.

The National Body for the Canadian Council for Animal Care sent four representatives on September12, 2000, to evaluate both the PSCI and PSC Elstow facilities. This committee tours animal research facilities every four years and is responsible for overseeing the care and use of animals for research, teaching and testing. They also determine if facilities know the principles of laboratory animal science and ethical issues involved in animal use.

The committee was very enthusiastic with the dedication staff at both facilities has shown for the health and well being of all stock, and in particular with the way that staff is involved with enhancing the richness of the pigs environment. The group-housed sows at PSC Elstow were also recognised as an attempt to improve an animal’s environment.

The Management Agreement established between Prairie Swine Centre Inc. and PSC Elstow Research Farm Inc. requires a percentage of my time to help with production and research procedures and concerns at PSC Elstow. As in all new facilities, at the time of start-up, frustrations may be evident in management and staff due to mechanical flaws with new equipment, facility inadequacies from construction and design mistakes, as well as being unable to gain access to the entire facility because of construction delays. Training of new staff, along with managing an immature herd, adds concerns when dealing with production performance and staff efficiencies. Management and staff are working well together, realising the importance of the Elstow facility both as a production and research facility.

GETTING THE WORD OUT

Lee Whittington
Manager Information Services

This publication marks our eighth year as a non-profit research corporation with a strong mandate and desire to increase the speed at which new research is adopted into practical production practice. The approach we have taken includes making use of the many sources that pork producers and their advisors use to get information, including books and magazines, meetings and the Internet. This year we have been active in all of these areas and I will highlight some of the more important activities that took place during the past calendar year.

The most significant step forward in serving a growing industry demand for detailed information was the hiring of an Assistant Manager of Information Services. Ken Engele joined the Centre in the fall of 1999 and has brought an abundance of enthusiasm and practical production and business management skills to the Centre. Ken's primary function includes developing the online Environmental Issues Resource Centre, a database of environmental information for pork producers and the general public. By having a second person dedicated to technology transfer to answer your inquiries, it allows more time for Centre personnel to be involved in face-to-face meetings and presentations with pork producers across the region.

Some of the activities that pushed us forward in meeting our goals of increasing the rate of technology adoption include the format of the *Annual Research Report*. This is the second year the report has been prepared using shorter articles, greater emphasis on practical applications of information and an easy-to-read editorial style. The publication will continue to evolve with the emphasis on productivity and financial implications from the adoption of new research. This issue also contains many articles from researchers from other institutions conducting research of interest to pork producers.

The Internet has received additional attention this year, starting with our new address to make the site easier to find: www.prairieswine.com. Our Environmental Issues Resource Centre now has scores of references in the database dealing with issues from manure treatments to odour control and nutrient management. Many new research and publication summaries have been added in the past year including the two new Fact Sheets: *Evaluating New Crop Grain* and *Environmental Issues Update*.

Sometimes there arises a need which cannot be timely addressed in the *Annual Research Report*, and the newsletter *Centred on Swine* is not large enough. For this situation timely Fact Sheets can be produced and distributed in *Centred on Swine* or by joint mailings with the cooperation of the pork industry associations. The Fact Sheet, *Evaluating New Crop Grain,* was produced this September in response to the extremely wet conditions and distressed grains being harvested in southern Manitoba. The Fact Sheet recaps what we currently know about feeding new crop grain, including variation in Digestible Energy content, impact of sprouted grain, the problems with ergot, and the importance of bushel weight.

The Focus on the Future Conference, a two-day event held in Saskatoon for the first time in March 1999, attracted over 100 people to hear about what is happening in leading edge research and how some production companies are applying this information to make better decisions in production and marketing of hogs. This conference replaces the Satellite Conference, which ran for the previous five years. During the industry review of the technology transfer program held in 1999, it was determined that adoption was better accomplished in face-to-face transactions with the potential users of information and that satellite conferencing should be used in the future where the intent is to deliver a message to a large audience and timeliness is critical (such as when there is a major change in factors affecting the profitability or sustainability of the industry as a whole).

This past year we introduced a new concept of half-day 'Open Houses' held at the Centre. There were three in total each focused on current research in a single discipline (nutrition, engineering, behaviour). These have been very well attended and plans are being made to transport this concept to Manitoba and Alberta.

Pork producers always view personal contact as the best way to receive information and this year's activities reflects our response to that desire. The number of presentations made by PSC staff in western Canada totaled 65.

Technology Transfer Team: Ken Engele, Mary Petersen, and Lee Whittington.

A number of activities were started this year that will add additional resources to the Centre's ability to provide technology transfer materials. A new position was created when Sask Pork developed and filled the Sask Pork Chair in Environmental Engineering for the Pork Industry. Resident in the Department of Agricultural Engineering and Bioresources at the University of Saskatchewan, the position also includes duties as adjunct researcher at Prairie Swine Centre. This position will be instrumental in establishing new collaborative research in the area of manure management and environment beyond the scope of the current personnel compliment at the Centre. Already Dr. Claude Laguë has participated in many workshops and provided written materials to help our communications in this important area.

Training plays an ever-increasing role in communicating information to the industry. This is reported in greater detail by Mary Petersen in her report within this publication. In summary the program has combined some of the latest science into the management of pork enterprises and has successfully delivered programs to some 138 people to date. Most recently Mary has developed a course in direct response to a need for specific training on Hydrogen Sulphide Awareness. This is being considered a 'must have' on many farms as the attention turns to emphasizing workplace safety.

Producers prefer face-to-face tech transfer.

Our next year is shaping up to have many new projects to improve technical communications between the Centre, the industry and the general public. Two projects specifically have direct relevance to the general public in addition to pork producers. The Welfare Issues Resource Centre is modeled after the Environmental Issues Resource Centre. Initial funding for the initiative comes from Ontario Pork and the developing Web site will provide a detailed review of the science behind the issues. Plans are moving ahead to develop a Viewing Gallery and Pork Industry Interpretive Centre to be located at the Elstow Research Farm. This facility will reach out to the education system, and the general public providing a 'real farm' where people can see first hand what a modern production facility looks and smells like. It is the objective of this project to provide a forum for focusing pork industry communications on bringing balance to the reporting and changing the perceptions of the industry in the minds of neighbours, regulators, schools groups and the general public.

At the conclusion of this year we thank all pork producers in Saskatchewan, Alberta and Manitoba for their financial support of the Centre's Research and Technology Transfer programs.

MANAGEMENT TRAINING PROGRAM RESPONDS TO PRODUCER NEEDS

Mary Petersen, B.Ed.
Coordinator, Management Training Program

The Management Training Program is a branch of the technology transfer program at PSCI and is a direct response to the needs of managers in the hog industry in western Canada. A manager who wishes to become well-rounded in the areas of production, facilities, business and staff, can choose from 20 courses offered. The program recognizes that managers must be diverse and have a depth of knowledge in all areas of operation.

The Management Training Program can be applied to any size of unit, as the skills it develops are essential across the industry. People newly placed in a management capacity generally require more skills to make the transition from herdsperson to barn manager.

Participants in the program can attend courses at two locations — Olds, AB and Watrous, Sask. Courses are offered once per month in each location from October through to June. This schedule allows completion of the program in two to three years. Each participant who successfully finishes the course receives a certificate from the Prairie Swine Centre.

Courses are delivered face-to-face to encourage interaction and networking. Participants agree that learning from each other is an important part of growing as a manager. Sharing mistakes, experiences and successes makes learning fun. "If we can share our mistakes and laugh over the situation, we are all growing as managers."

Issues in Ag. Management. Jan 9-10, 2001:
l-r: Wes Mann, Jay McGrath, Tony Mycock, Patrick Loepe, Brenda Beaulac, Danielle Chubak, Ledge Watt, Elayna Bowie, Kyla Keeping

Issues in Ag. Management. Jan 9-10, 2001:
l-r: Elayna Bowie, Ledge Watt, Kyla Keeping, Brenda Beaulac

MANAGING IS A CRITICAL PART OF BUSINESS

Mary Petersen, B.Ed.
Coordinator, Management Training Program

The ability to manage is not something that most people are born with, but the skills can be learned. The Management Training Program is designed to help people learn how to manage staff, production, business and facilities. A manager in the hog industry must be well-rounded and possess skills that will ensure the sustainability of the unit.

The Management Training Program consists of 20 courses designed to give the manager the tools he needs to succeed as a manager. Courses fall into four topic areas: human resources, production, business and facilities.

Certification for the program will be issued by the Prairie Swine Centre. This will offer a career path for people who want to be involved in the hog industry for the long term, whether they be owners, managers, assistant managers or aspiring managers.

Participants in the program can attend courses at two locations—Olds, AB and Watrous, Sask. Courses are offered once per month in each location from October through to June. This schedule allows completion of the program in two to three years.

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Being responsive to the needs of the industry is part of technology transfer at the Prairie Swine Centre. This mandate sparked the development of a Hydrogen Sulphide Awareness course, designed specifically for the swine industry. This six hour course is designed for any person working in a hog barn. It explains the properties of hydrogen sulphide gas, how it builds up in liquid manure, how it is released, why it is a danger, and how to handle liquid manure safely. It also covers rescue techniques and the use of a self-contained breathing apparatus.

The course was developed with a lot of help from many people in the hog industry. These people were managers of hog barns, hog barn workers, Occupational Health and Safety personnel, research scientists at PSCI and faculty of the U of S Department of Agriculture.

The management Training Program is continually growing. To date, 191 students have attended 21 courses with an average class size of nine. Fifteen courses have been delivered in Saskatchewan and five courses in Alberta.

As well as open delivery of courses to producers and managers, the Management Training Program has attracted the interest of sales representatives from a feed company, who attended one course at PSC Elstow Research Farm. It was delivered exclusively to their sales representatives from across Canada.

FOCUS: WELFARE, ENVIRONMENT, COST OF PRODUCTION

The five year research program of Prairie Swine Centre has six main objectives, and broadly covers the areas of nutrition, engineering, behaviour and the environment. In detail the objectives are as follows:

Objective 1.

To reduce the cost of production in western Canada by at least $2 per pig sold, by defining cost-effective feeding strategies for animals in the growout phase.

Objective 2.

To provide greater economy and flexibility in swine diet formulation, and to increase use of locally grown commodities, by developing recommendations for use of "opportunity" feeds in hog production.

Objective 3.

To develop animal care guidelines and management procedures consistent with the needs of the swine industry, but derived through the consideration of swine behaviour.

Objective 4.

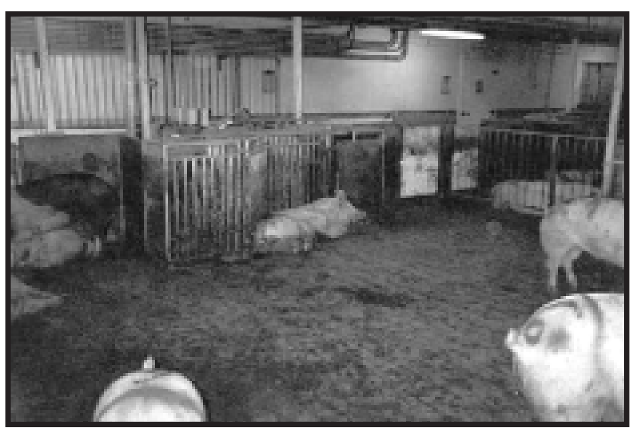
To develop systems for improving air quality inside hog barns, to enhance human and animal health and comfort and to reduce external odour emissions.

Objective 5.

To reduce hog production costs by optimizing the physical environment in commercial hog barns.

Objective 6.

To develop new information on operating systems and management procedures which ensure the long-term environmental sustainability of pork production.



The electronic sow feeding system located at PSC Elstow Research Farm enhances the capabilities of research conducted under objective 3. This project allows three different sow housing systems to be assessed within one herd.

DIETARY ENZYME IMPROVES NUTRIENT DIGESTIBILITY OF CANOLA MEAL-DIETS

Ruurd T. Zijlstra, John F. Patience,
P. Howard Simmins [1]

Summary

A trial was conducted with cannulated weaned pigs to study effects of a dietary enzyme on nutrient digestibility. Supplemental enzymes that degrade some of the NSP were useful in improving ileal digestibility of energy and amino acids, but not total tract digestibility of energy.

Introduction

The nutritional value of canola meal and cereal grains is limited by fiber, also named non-starch polysaccharides (NSP). The objective was to evaluate effects of supplementation of a wheat or barley-canola meal diet with NSP-degrading enzymes (ß-glucanase and xylanase) on digestibility of energy and amino acids.

Experimental Procedures

Cannulated weaned pigs were fed 25% canola meal diets with either barley or wheat as the main cereal, with or without a dietary enzyme mix. Diets were formulated to 3150 kcal DE and 10.6 g digestible lysine, and were thus limiting in energy but not amino acids.

Results and Discussion

Dietary enzyme improved ileal digestibility of energy from 63 to 70% in the barley- and from 68 to 73% in the wheat-canola meal diet ($P < 0.05$), resulting in a marked improvement in the amount of DE digested by the end of the small intestine (Figure 1). An enzyme effect could not be detected on total tract energy digestibility ($P > 0.10$), and the resulting dietary DE content was similar among diets (Figure 2). Although the diets were formulated to 3150 kcal DE/kg diet, the measured DE content at 90% DM was 2870 for the barley- and 2920 for the wheat-canola meal diet. Dietary enzyme did not affect amino acid digestibility for the barley diet (81%), but improved apparent lysine digestibility from 81 to 84 % for the wheat-canola meal diet ($P < 0.05$).

Implications

Together these results indicate that using supplemental enzymes with a barley- or wheat-canola meal diet can increase the amount of energy available to support protein deposition. One strategy to maximize the benefits of supplemental enzymes can be to formulate diets to be limiting in energy (thus reducing cost) and estimate the improvement in available energy to reach a target for energy required to support protein deposition.

Acknowledgements

Strategic funding was provided by SaskPork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Development Fund. Project funding was provided by Canola Council of Canada, Finnfeeds International, Saskatchewan Canola Development Commission, and the Program for Export Market Development.

Figure 1. Ileal digestible energy of canola meal diets.

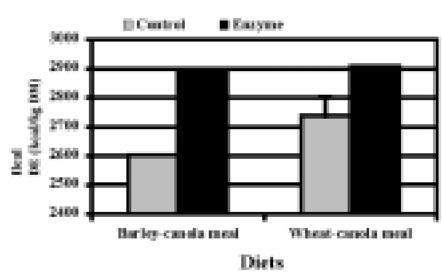
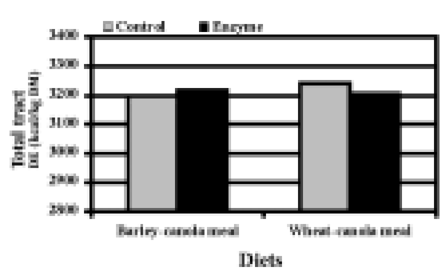


Figure 2. Total tract digestible energy of canola meal diets.



Enzymes can allow lower cost feeds to deliver acceptable gains.

Finnfeeds International Ltd., Marlborough, UK [1]

EFFECT OF DIETARY ENZYME ON BARLEY ENERGY DIGESTIBILITY

Ruurd T. Zijlstra, Brian K. Sloan [1], and John F. Patience

Summary

Nutrient digestibility in barley diets fed to grower pigs can be improved with dietary enzymes. The response to enzymes depends on the specific barley sample included in the diet. Ingredient evaluation and enzyme supplementation should be integrated to optimize overall nutrient utilization and to maximize benefits of enzymes.

Enzyme supplements can be effective, depending on the quality of the barley.

Introduction

A 20% range exists in DE content of barley, which is caused primarily by changes in concentrations of fibrous fractions. Supplemental enzymes that digest fibrous fractions might thus be beneficial in reducing differences in DE content in barley.

Experimental Procedures

Samples of barley with a predicted range of DE content and hull-less barley were selected using chemical characteristics and a near-infrared spectroscopy calibration. In two studies, barley samples were included at either 96% (Exp. 1) or 66% of the diet with 25% soybean meal and 5% canola meal (Exp. 2), with or without enzyme (RovabioTM Excel; 500 U ß-glucanase/kg diet) fed to grower pigs.

Results and Discussion

In Exp. 1, dietary enzyme improved apparent total tract energy-digestibility 7% for barley 2 and 3% for barley 1(Figure 1), and apparent ileal energy-digestibility 13% for barley 2 and 8% for barley 1, indicating that barley DE content can be improved up to 7% using supplemental enzymes.

In Exp. 2, dietary enzyme improved apparent total tract energy-digestibility 2% for barley 1 (Figure 2), 3% for barley 2, and 2% for hull-less barley, but not for barley 3. Enzyme supplementation improved apparent digesta energy-digestibility 7% for barley 2 and 6% for hull-less barley but not for barley 1 or 3, and apparent digesta total-essential AA-digestibility 3% for barley 2. Overall, hindgut fermentation diminished the increase in energy-digestibility at the distal ileum.

Implications

Dietary enzyme improved digestibility of energy and amino acids; however, responses depended on the specific barley sample. Thus, enzyme supplementation should be integrated with ingredient evaluation to maximize benefits of enzyme supplementation.

Acknowledgements

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund. The presented work was supported financially by Aventis Animal Nutrition, Atlanta, GA.

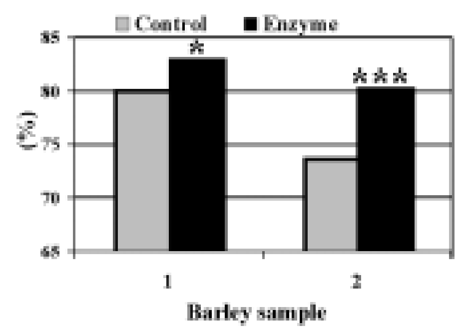


Figure 1. Apparent total tract energy digestibility for two barley samples.

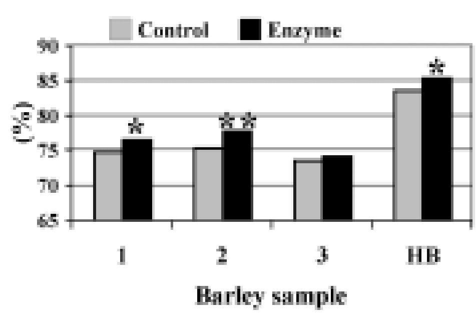


Figure 2. Apparent total tract energy digestibility for three diets including barley and one diet including hull-less barley (HB).

Aventis Animal Nutrition, Atlanta, GA [1]

DIGESTIBILITY OF ENERGY AND AMINO ACIDS IN HIGH-OIL CORN

Ruurd T. Zijlstra, Tom E. Sauber [1],
and John F. Patience

Summary

High-oil corn is used as a source of nutrients, especially energy, to meet requirement of pigs. In the present study, DE content and digestibility of energy and amino acids of high-oil corn was characterized and related to chemical characteristics.

The DE content of high-oil corn was 5% higher than regular corn. Corn DE content could be predicted using gross energy (GE) or oil content. High oil corn is clearly a source with a high DE content.

Introduction

Digestibility of energy and amino acids of high-oil corn has not been characterized thoroughly or related to chemical characteristics. Thus, the objective was to compare four near-isogenic sample-pairs of high-oil and regular corn and one standard corn sample for chemical and nutritional characteristics.

Experimental Procedures

Corn samples were analyzed by proximate analyses. Diets consisting of one specific corn sample (96.3%), vitamins and minerals, and chromic oxide as an indigestible marker were fed to grower pigs cannulated at the distal ileum, for six pigs per diet.

Results and Discussion

In high-oil versus regular corn, oil content was 4.2% higher (9.1 vs 4.9%), resulting in a 6% higher GE content (4853 vs 4589 kcal/kg DM), and protein content was 9.5 versus 9.1%, acid-detergent lignin 0.51 versus 0.41%, and starch 68.2 versus 71.3%.

Total tract energy digestibility was 1.1% lower (87.4 versus 88.3% in high-oil versus regular corn; however, DE content was 5% higher in high-oil versus regular corn (4238 versus 4052 kcal/kg DM). The DE content could be predicted using single-regression by corn GE (R2 = 0.93), oil (R2 = 0.90; Figure 1), and protein (R2 = 0.49). Ileal E digestibility was similar (75.4 vs 76.4%) between high-oil versus regular corn; however, ileal DE content was 4% higher in high-oil versus regular corn (3660 versus 3503 kcal/kg DM).

In Figure 1, equations to predict corn GE, DE, and ileal DE content using corn oil content are presented. The figure clearly illustrates the large range in corn oil content and the positive effects of increased oil content on corn DE content.

High oil corn provides more energy and amino acids to the pig.

Apparent ileal digestibility of lysine was 2.4% higher in high-oil versus regular corn (64.0 versus 61.6%), although less difference was observed in standardized digestibility of lysine (76.3 versus 75.5%). The increase in oil content within each near-isogenic sample pair was related (R2 = 0.47) to an increase in apparent ileal lysine digestibility.

Implications

In summary, feeding high-oil versus regular corn does result in more energy and amino acids that are available to the pig to support metabolic functions.

Acknowledgements

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund. The presented work was supported financially by DuPont Specialty Grains, Johnston, IA.

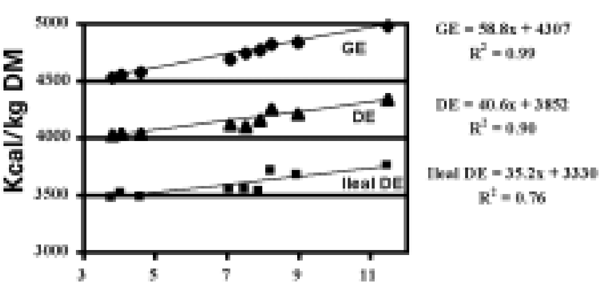


Figure 1. Effect of Corn Oil Content (% DM) on Energy Content (kcal/kg). To determine corn gross energy (GE), DE, or ileal DE, determine its oil content and use the provided equations.

[1] DuPont Specialty Grains, Johnston, IA

EFFECT OF AMINO ACID INTAKE IN GESTATION ON SOW PERFORMANCE

Dana R. Cooper, John F. Patience, Ruurd T. Zijlstra and Meike Rademacher [1]

Supplementing lysine at more than the recommended rate isn't necessary.

Summary

Proper management of the breeding herd leads to an increase in output of pigs throughout subsequent stages of production. Re-defining amino acid requirements for high producing sows in gestation will lead to maximized productivity and efficiency. Therefore, the effect of lysine level (below and above NRC, 1988) in the gestation diet on sow performance was determined. Total lysine intakes greater than 10.6 g/d (8.3 g Dlys/d) in gestation did not improve sow productivity in the present study.

Introduction

Improved production practices are needed to better suit the capabilities of 'new' high-producing genotypes to ensure their genetic potential is being realized. In particular, nutrient requirements of sows need to be re-defined. Furthermore, these nutrients need to be supplied at the lowest possible cost while minimizing the amount of nutrients being excreted into the manure. The objective of this experiment was to evaluate the effect of two levels of amino acids on sow productivity.

Experimental Procedures

At mating, 419 PIC sows were assigned randomly within parities 1, 2, and 3+ to a gestation diet containing either 0.44 (low lysine) or 0.55% (high lysine) total lysine and 3100 kcal DE/kg; other indispensable amino acids were adjusted to lysine based on ideal protein ratios. The two levels of lysine were set above and below the recommendations of NRC (1988). Feed allowance in gestation was determined factorially using estimated DE requirements for maintenance, maternal gain and conceptus growth. Sows were allowed free access to lactation diet.

Results and Discussion

Sows gained 49.6 ± 0.5 kg in gestation and 4.8 ± 0.6 kg in lactation. Sows farrowed 12.0 ± 0.1 piglets and 11.2 ± 0.1 live born piglets per litter. Gestation lysine level did not affect gestation body weight gain, regardless of parity ($P > 0.10$). Gestation BW gain was affected by parity ($P < 0.05$) as sows of parity 1 and 2 were actually fed to gain more weight than sows of parity 3 and higher ($P < 0.05$; Figure 1). Gestation weight gain was correlated negatively with lactation weight changes ($P < 0.05$). A treatment x parity interaction for backfat was found in lactation ($P < 0.05$), parity 2 sows on the HL gestation diet lost more backfat in lactation than parity 2 sows on the LL gestation diet. The total number of pigs born and the pigs born alive per litter were not affected by gestation lysine level ($P > 0.10$), but were affected by parity with parity 1 sows farrowing fewer piglets ($P < 0.05$). Gestation weight gain and the number and weight of piglets born and born alive were correlated positively ($r = 0.41, 0.40, 0.51, 0.51$ for piglets born per litter, piglets born alive per litter, total weight of the litter and total weight of the piglets born alive, respectively; $P < 0.05$). Every kg BW gain in gestation corresponded to an extra 0.14 piglets born and 0.04 piglets born alive. This resulted in 50 g additional litter weight at birth. Results are summarised in Table 1.

Implications

Feeding sows to meet and not exceed nutrient requirements will lead to increased efficiency and sustainability. For lysine, total intakes greater than 10.6 g/d (8.3g Dlys/d) did not improve sow productivity in the present study, indicating that NRC (1988) recommended lysine requirements met the needs of these sows for maximum productivity.

Acknowledgements

Strategic program funding provided by SaskPork, Alberta Pork, Manitoba Pork, and Saskatchewan Agriculture and Food Development Fund. Degussa Hüls AG provided direct funding for this project.

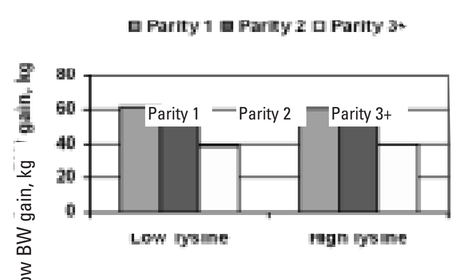


Figure 1: Effect of lysine level on sow BW gain

Low lysine High lysine

Degussa Hüls AG [1]

Table 1. Sow performance in gestation and lactation

Gestation Diet					
	Parity	LL	HL	Mean	SEM
Sow Traits					
Initial Body Weight (kg)	1	159.2	157.1	158.2	1.6
	2	168.2	168.0	168.1	1.5
	3+	207.9	206.7	207.3	1.1
	Mean	178.4	177.3	177.9	1.8
Body Weight Gain [a] (day 1 to 110; kg)	1	61.7	60.8	61.3	1.2
	2	60.4	59.7	60.1	1.2
	3+	38.3	39.4	38.9	1.3
	Mean	53.5	53.3	53.4	.8
Change in Backfat [b] (day 1 to 110; mm)	1	1.6	2.2	1.9	.4
	2	2.6	1.1	1.9	.3
	3+	2.1	2.0	2.1	.3
	Mean	2.1	1.8	2.0	.2
Weight Change (day 1 to weaning; kg)	1	3.0	-1.9	.5	2.0c
	2	5.9	7.7	6.8	1.5
	3+	6.0	5.5	5.8	1.5
	Mean	5.0	3.8	4.8	1.2a
Initial Backfat (mm) (day 1)	1	16.4	16.8	16.6	.4
	2	16.4	15.9	16.1	.3
	3+	16.3	16.2	16.3	.2
	Mean	16.3	16.3	16.3	.1
Backfat Change (day 1to weaning; mm)	1	-.2	.2	-.1	.3
	2	.2	-.3	0b	.2
	3+	.2	.4	.3	.2
	Mean	.1	.1	.1	.1
Avg. litter size					
Total Born[a]	1	11.9	11.1	11.5	.4
	2	12.0	12.2	12.1	.3
	3+	12.5	12.5	12.5	.3
	Mean	12.1	11.9	12.0	.2
Born alive[a]	1	10.7	10.3	10.5	.4
	2	11.4	11.4	11.4	.3
	3+	11.8	11.9	11.8	.3
	Mean	11.3	11.2	11.2	.2
Avg. litter weights, kg					
Total born[a]	1	16.7	14.9	15.9c	.6
	2	18.4	18.8	18.6	.5
	3+	19.4	19.3	19.4	.4
	Mean	18.2	17.7	18.0	.3
Born alive[a]	1	15.3	14.0	14.7	.6
	2	17.6	18.0	17.8	.5
	3+	18.7	18.6	18.7	.4
	Mean	17.2	16.9	17.1	.3
Avg. piglet birth weights[a]	1	1.48	1.41	1.45	.04
	2	1.61	1.59	1.60	.03
	3+	1.56	1.56	1.56	.03
	Mean	1.55	1.52	1.55	.02

[a] parity effect ($P < .05$). [b] parity x treatment interaction ($P < .05$). [c] Treatment effect ($P < .05$).

SOW BODYWEIGHT CHANGES IN GESTATION

Dana R. Cooper, John F. Patience, Ruurd T. Zijlstra and Meike Rademacher [1]

Summary

Defining nutrient requirements and feeding strategies for the modern high-producing sow is a step leading to greater efficiency in the breeding herd. Results demonstrated that setting target weight gains in gestation and feeding to meet these targets might not always provide predictable results.

Actual litter size and weight are the best indicators of feed needs.

Introduction

There are two steps in the design of a feeding strategy. The first is to set reproductive targets including the amount of maternal weight gain for sows of differing parities and the amount of reserves a sow can use for milk production in lactation. The second step is to set nutrient requirements to meet these specified targets. Models have been developed for sow nutrient requirements in gestation. These models attempt to partition nutrient requirements into three components (maintenance, growth of conceptus and reproductive tissues and maternal growth). By attempting to partition requirements, factors are added up, thus accounting for the factorial approach to determining nutrient requirements. The object of this experiment was to evaluate the factorial approach to defining energy requirements in pregnant sows.

Experimental Procedures

Daily feed allowance in gestation was determined using the maintenance requirement for energy of 110 kcal DE/kg BW 0.75 and total target sow BW gains, including maternal gain and growth of the conceptus, of 55, 50, 40, 30 and 20 kg for parities 1, 2, 3, 4 and 5 and higher, respectively. Feed allowances were calculated using BW at mating and the target BW gains set for each parity. Example calculations are demonstrated in Table 1.

Daily feed allowance of sows in gestation was closely monitored. Sows were fed their daily allowance as one meal in the morning. Sow BW was measured at mating, d 35, 75 and 110 gestation. The experiment was conducted over three replicates. After the first replicate, it was apparent that first and second parity sows gained an average of 9.6 and 13.3 kg more than targeted, respectively. In replicates 2 and 3, the daily energy allowances of these two parities was adjusted downward based on the energy required for protein and lipid gain to achieve the prescribed gestation BW gain. The calculation resulted in decreasing the average daily feed allowance by 100 g/d.

Results and Discussion

Sows gained an average of 10.6 kg above the target total gestation BW gain. It was clear that this model over-predicted DE allowance for sows in gestation, therefore, performance data for the sows was entered into the NRC (1998) model (Table 2). The actual number of piglets farrowed was put into the NRC (1998) model, a component not entered into the original model that was used. Comparisons between the predicted BW gain and the actual BW gain were then made. The deviation between the predicted and actual BW gains was then organized by parity, BW at breeding, total number of piglets born and the total weight of the litter born (Figures 1 and 2). The deviations between predicted and actual gains (NRC prediction – Actual BW gains) decreased with increased parity and initial BW at breeding until the 5th parity and a BW range of 210-240 kg, where it then increased. NRC (1998) obtained the closest estimate of BW gain in gestation for sows with litters larger than 11 piglets and litters weighing between 14-17 kg at birth.

Implications

Predicting daily DE allowances that will maximize sow and litter performance is possible with sows between parity 3 and 5. There is too much variation in younger parity sows and older parity sows to predict sow performance with any accuracy; therefore, there is a need for further research into this area. The size and weight of the litter at farrowing is important in determining the BW gain of the sow in gestation. Therefore, using the actual litter size and weight within a sow herd is desirable when using a factorial approach to determine daily feed allowance.

Acknowledgements

Strategic program funding provided by SaskPork, Alberta Pork, Manitoba Pork, and Saskatchewan Agriculture and Food Development Fund. Degussa Hüls AG provided direct funding for this project.

Degussa Hüls AG [1]

Table 1. Estimated daily DE requirements in gestation using original model estimates. Based on target weight gains in gestation.

						Actual DE intake (kcal/d)		
Parity	No. sows	Ave. initial BW, kg	Target Wt. gain, kg[a]	$DE_{Maint.}$[b]	$DE_{Matgain}$[c]	$DE_{Conceptus}$[d]	DE_{Total}	Daily feed allowance, kg/de
1	99	142	55	5161	1697	411	7269	2.3
2	102	168	50	5700	1662	411	7773	2.5
3	43	193	40	6129	1114	411	7654	2.5
4	54	208	30	6348	611	411	7370	2.4
5	44	220	20	6488	249	411	7148	2.3
6	23	230	20	6703	249	411	7363	2.4
7	23	233	20	6770	249	411	7430	2.4
8	12	236	20	6829	249	411	7489	2.4

[a] Including both maternal and conceptus gain.

[b] Maintenance requirement of 110 kcal DE/kg BW 0.75). Body weight is average of initial BW and final BW based on target weight gain in gestation.

[c] Maternal BW gain requirement is sum of requirement for protein gain (12.78 kcal/g) and lipid gain (13.05 kcal/g). Assumes that maternal gain is 12.5% protein, resulting in a lipid:protein ratio in maternal gain of about 2:1.

[d] Assuming 20 kg conceptus and reproductive tissue gain over 115 days (174 g/d), assuming 18.5% protein (32.2 g/d) and an energetic cost of 12.78 kcal/g.

[e] Assuming DE of diet was 3100 kcal/kg. Subsequent digestibility trial showed actual DE content of 3150 kcal/kg.

Table 2. NRC (1998) estimate of maternal body weight gain using actual daily DE intakes in gestation

Parity	No. sows	Net maternal BW gain, kg[a]	Litter size[b]	DE_{maint}[c]	$DE_{conceptus}$[d]	Actual daily DE intake, kcal/d[e]	DE for maternal gain, kcal/d[f]	NRC estimate of total BW gain, kg[g]	Actual total BW gain, kg
1	99	36	11.2	5607	419	7269	1234	57	61
2	102	33	11.9	5829	445	7773	1499	58	60
3	43	22	12.4	6261	463	7654	930	50	50
4	54	14	12.6	6501	471	7370	398	44	42
5	44	3	13.2	6650	494	7148	4	37	33
6	23	7	12.3	6884	457	7363	22	37	35
7	23	0	13.7	6905	511	7430	14	41	31
8	12	1	11.5	6924	427	7489	138	37	27

[a] Maternal weight gain (kg) = Gestation weight gain (kg) – (2.28 x No. of pigs).

[b] Total piglets born.

[c] Maintenance requirement of 110 kcal DE/kg BW 0.75. Body weight is the average of the initial weight and final weight based on actual weight gains of the sows in the experiment.

[d] DE required for daily gain of the products of conception is 37.3 kcal/pig.

[e] Actual daily DE intake (kcal/d) based on original model.

[f] DE (kcal/d) remaining after estimates for maintenance and conceptus gain (based on NRC, 1998 model) are subtracted from the actual intake of the sow in gestation.

[g] Estimate of BW gain from NRC (1998) model using actual daily DE intakes obtained from original model.

Figure 1: Deviation between predicted and actual BW gain by parity

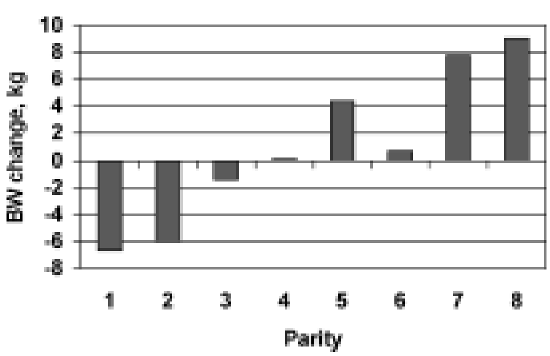
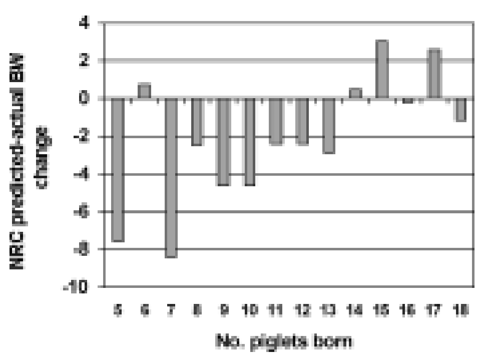


Figure 2: Deviation between predicted and actual BW gain by number of piglets born



PHOSPHORUS REQUIREMENT OF GROWER PIGS

E. David Ekpe and Ruurd T. Zijlstra

Summary

Over-supplementation of diets with phosphorus (P) to maximize pig performance results in excess P in manure, which could have an impact on environment if not managed properly. A better understanding of P needs might enable diet formulation closer to requirements, and thereby reduce the amount of P in manure. The digestible P requirement of grower pigs was 6.2 g/d at a protein deposition range of 153 to 180 g/d. The daily requirement of P might be different for pigs with protein deposition outside this range.

Feeding phosphorus closer to requirement results in lower costs to environment and pocket book.

Introduction

Nutrient management is becoming important with the increased density of the pork industry. Excess P in feeds ends up in manure and could impact the environment if not managed properly. Reducing the amount of P in manure requires knowledge of P requirements. Five levels of dietary P (0.4 to 0.84%) were used to determine P requirements of grower pigs.

Experimental Procedures

Average daily gain and feed efficiency were monitored for five weeks. Amounts of P in feed, feces, urine, and blood plasma were determined in a metabolism study. Regression analysis was used to develop relations between P intake and performance and metabolism variables to determine P requirements.

Results and Discussion

Increased amount of P in feeds resulted in increased P intake, ADG, feed intake and feed efficiency, but also in increased amount of P excreted in urine and faeces (Figure 1). The ADG and feed efficiency ranged from 0.73 to 0.91 kg/d and 0.41 to 0.47, respectively, at a protein deposition rate of 153 to 180 g/d. The digestible P requirement was 6.2 g/d based on ADG, but higher based on bone phosphorus (Figure 2). The P requirement was higher than reported in NRC (1998), perhaps due to a high protein deposition rate.

Implications

Reducing the amount of P in feeds can reduce the amount of P in manure. This strategy involves feeding of P closer to requirements, and eliminates the cost of excess P added to feeds, and thus, increases the net income. An improvement in P utilization is economically beneficial to pork producers, and is also important for sustainable swine production.

Acknowledgements

Strategic funding provided by SaskPork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund. The presented work was supported financially by the Alberta Agricultural Research Institute

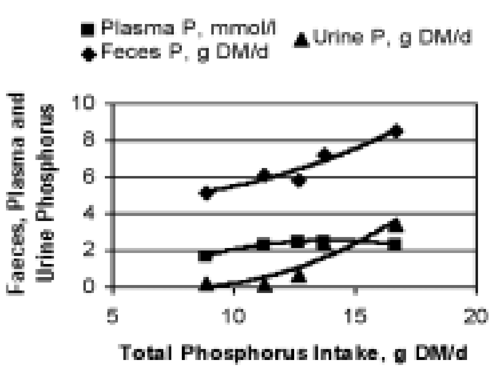


Figure 1: Phosphorus in feces, urine and plasma

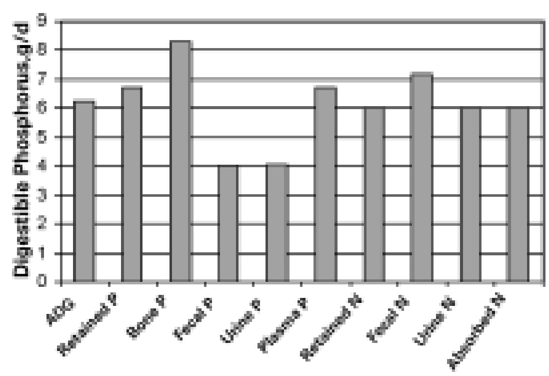


Figure 2: Digestible phosphorus requirements; b phosphorus and nitrogen metabolism

MICRONIZED AND FLAKED WHEAT IN NURSERY DIETS

**Alison Orr, Raelene Petracek,
Murray Pettitt, Eduardo Beltranena**

Summary

Micronization and flaking are likely to improve grain nutrient utilization by young pigs. One hundred sixty pigs weaned at 13.4 ± 1.0 days of age were used to determine the effect of the inclusion of either micronized, flaked and ground or just ground white wheat (AC Karma) in nursery diets. Micronization and flaking increased the wheat's nutrient availability and(or) digestibility resulting in heavier weights, faster weight gain and improved feed conversion efficiency for the nursery period following early weaning at 13 days of age.

Introduction

Micronization is likely to gelatinize the starch thus increasing grain digestibility in young pigs. Flaking increases the kernel surface area increasing the opportunity for gut secretions and enzymes to improve the digestibility. Early weaned pigs are the ones most likely to benefit from receiving diets containing micronized grains because endogenous enzymatic secretion is not fully established.

Experimental Procedure

One hundred sixty pigs weaned at 13.4 ± 1.0 days of age were used to determine the effect of the inclusion of either micronized, flaked and ground or just ground white wheat (AC Karma) in nursery diets on body weights, average daily weight gain, feed disappearance and feed conversion efficiency during a 35-day study.

Results

The inclusion of micronized, flaked and ground wheat in the nursery diet did not affect feed disappearance, but increased body weights seven days post-weaning, increased weight gains for the 0 – 7 day and 21 – 35 day periods and improved feed conversion efficiency for the 21 – 35 day and 0 – 35 day (overall) periods.

Conclusions

The results of this study indicate the micronization and flaking of AC Karma white wheat increased nutrient availability and(or) digestibility resulting in heavier weights, faster weight gain and improved feed conversion efficiency of pigs for the 35 day nursery period following early-weaning at 13 days of age.

It was $0.07 cheaper per pig to feed the micronized, flaked and ground wheat diet compared to the just ground wheat diet.

The reduced pig performance observed in this study compared to industry benchmarks was related to the fact that the diets were formulated to result in linear but not peak growth performance in order to better appreciate differences due to wheat processing.

Further studies would involve different varieties of feed wheat. AC Karma has a low protein content, and therefore a better response may be obtained with other feed wheats.

Micronized and flaked wheat offers better nutrition for less cost.

Acknowledgements

Funding for this study was provided by the Saskatchewan Agriculture Development Fund and InfraReady Products Limited.

Effects of micronization and flaking of AC Karma wheat on pen average body weights, daily feed disappearance, daily weight gain, and feed:gain of 13 day-old weaned pigs.

	Ground Wheat	Micronized, Flaked and Ground Wheat	SEM	*P* value
n, pens	16	16		
Body weights, kg				
Day 0	4.60	4.61	0.03	0.77
Day 7	4.71	4.94	0.07	0.01
Day 21	7.81	7.95	0.17	0.43
Day 35	14.43	14.85	0.25	0.07
Daily feed disappearance, kg				
0 - 7 days	0.12	0.13	0.01	0.46
7 - 21 days	0.36	0.34	0.01	0.30
21 - 35 days	0.76	0.76	0.02	0.53
0 – 35 days	0.47	0.47	0.01	0.46
Daily weight gain, kg				
0 - 7 days	0.01	0.05	0.01	0.01
7- 21 days	0.22	0.22	0.01	0.40
21 - 35 days	0.47	0.49	0.01	0.02
0 – 35 days	0.28	0.29	0.01	0.09
Feed:Gain				
0 -7 days	1.69	2.46	1.81	0.02
7 - 21 days	1.62	1.60	0.05	0.51
21 - 35 days	1.61	1.54	0.02	0.02
0 – 35 days	1.69	1.59	0.03	0.01

NEW METHOD TO DETERMINE BARLEY DE IS INDICATIVE OF PERFORMANCE

Miladel Casano [1] and Ruurd T. Zijlstra

Summary

The DE content of grains is usually measured in protein-deficient diets to which pigs have restricted access. An alternative method with pigs given free access to a complete diet affected the hierarchy of barley samples for DE content. In the new method, DE intake indicated grower pig performance.

Introduction

The DE content of grains is measured with the test ingredient as 96% of a diet with a restricted level of intake. Thus, feeding level and nutrient content do not reflect practical conditions and prevent measurement of voluntary feed intake. A modified procedure using nutrient-adequate diets to which pigs have unrestricted access is proposed. The objective was to evaluate the DE content of barley using the two methods.

Experimental Procedures

Five barley samples over a range of ADF (5.8 to 8.8% as fed), NDF (15.7 to 21.3%) and CP (9.0 to 12.4%) were incorporated into 2 diets: standard (96% barley, 2950 kcal DE/kg, 0.8 g dlys/Mcal DE) and complete (75% barley, 18% soybean meal, 2% canola oil; 3165 kcal DE/kg, 2.2 g dlys/Mcal DE). The standard diet was offered at 3 x DE maintenance requirement (restricted-standard diet) while the complete diet was given ad libitum (ad lib-complete diet). Barley DE content was calculated by direct and difference methods.

Results and Discussion

In restricted-standard diet pigs, restriction of feed allowance and dietary amino acids resulted in severely reduced average daily gain (ADG) compared to ad lib-complete diet pigs. (Figure 1). Overall, ADFI of ad lib-complete diet pigs ranged from 1680 to 1780 g/day. The differences in feed intake resulted to differences in DE intake that were highly correlated to ADG (r = 0.98).

The DE content ranking of barley samples was altered by the method used (Figure 2).

Implications

Results indicate that barley DE content depended on the method used. Also, DE intake was a good indicator of performance when measured using the ad lib-complete diet method. Measurement of DE intake might be a new method to evaluate the true nutritional value of feedstuffs.

Acknowledgements

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

Measuring digestible energy gives a better measure of nutritional value.

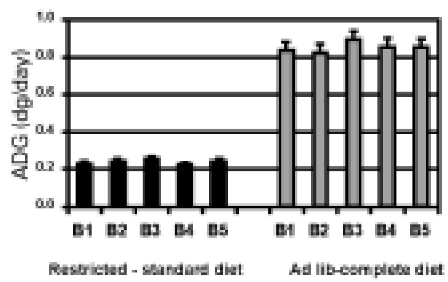


Figure 1. The ADG of pigs fed five barley samples according to two methods.

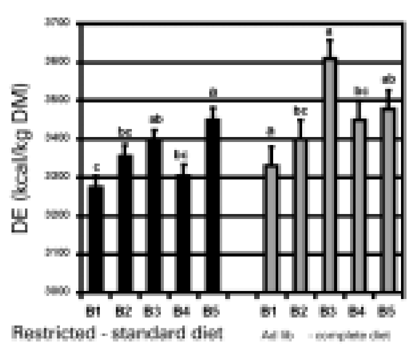


Figure 2. The DE content of five barley samples according to two methods.

[1] PSCI and Department of Animal and Poultry Science, University of Saskatchewan

DIETARY FACTORS INFLUENCING WATER CONSUMPTION

Marnie I. Shaw and John F. Patience

Adequate water is essential with high-protein diets.

Introduction

Water is often referred to as 'the forgotten nutrient', even though it is essential to biological functioning and required by animals in greater quantity than any other nutrient. Unlike other nutrient sources, water is abundant, inexpensive and usually given ad libitum to pigs in commercial production units. However concern relating to environmental pollution and the cost of storing, hauling and spreading manure is leading to greater interest in water consumption patterns in pigs.

Water makes up about 70% of the lean adult body, and some tissues contain up to 90% water (Maynard et al., 1979). Water is essential for the processes of growth, reproduction and lactation. A wide variety of functions in the body require water including nutrient transport, waste excretion and body temperature regulation.

The water requirements of pigs have been estimated on the basis of feed intake: Yang et al. (1981) gave a minimum water to feed ratio of 1.6, while Bigelow and Houpt (1987) suggested a 1.5-2.0 water to feed ratio. Therefore, when given free access to feed, water intake will increase with increased feed consumption. It is important to note that these estimates are given with the assumption of a thermoneutral environment. In situations of high environmental temperature, for example, water intake will increase as the animal attempts to maintain constant internal body temperature. Water consumption includes intake related to stress, boredom or hunger – pigs may drink water in an attempt to fill their gut when on a restricted ration of feed. In addition, wastage must be taken into account to avoid exaggeration of water consumption measurements. Overall, free access to water is recommended to prevent deprivation due to individual or environmental variation.

Many factors affect water intake by the pig, including environmental temperature and humidity, social conditions and diet composition. The purpose of this paper is to highlight the impact of diet on water consumption. Understanding how diet formulation affects water demand by the pig will aid in the development of management strategies to reduce water consumption without compromising optimum performance and animal well-being.

Water Consumption and Protein

The kidneys are responsible for filtering and removing toxins and waste products from the body. If the amount of available drinking water is constant, the kidneys are able to concentrate the urine more and more as the waste to be excreted increases. This ability to concentrate urine is limited, however, and varies among species. For example, the desert camel can produce urine that is over three times as concentrated as what the pig's kidneys are able to produce; the camel therefore requires less available drinking water for the excretion of waste products than does the pig.

When an animal ingests protein in excess of the body's requirements for growth and other physiological functions, the excess is removed from the body mainly in the form of urea in the urine. Amino acids contain nitrogen and are the building blocks of protein. Often included in the diet are synthetic amino acids such as lysine or threonine; the dietary supply of amino acids can be unbalanced with respect to the animal's requirement, creating an excess of nitrogen in the digestive tract. Water intake may increase in response to the excess nitrogen so that a dilute urine may be produced.

Studies designed to investigate the effect of level of crude protein in the diet on water utilisation patterns have shown that both water intake and urinary output increase as protein level increases. For example, Wahlstrom et al. (1970) found that pigs fed 12% crude protein consumed 3.90 litres of water per day, while those fed a diet of 16% protein increased their water consumption to 5.26 l/d. Close et al. (1983) found that water intake was significantly increased when pigs were given a high protein diet. Similarly, increasing the protein content of the diet from 319 to 433g resulted in an increased urine output, from 1873 to 2893g per animal per day (Pfeiffer and Henkel, 1991). This study showed that it was not necessary for pigs to lower their water intake in response to lower protein content of the diet, but it is essential to increase daily water consumption when protein levels in the diet are raised. This in turn leads to increased urine production as the excess nitrogen is excreted via the kidneys.

Water Consumption and Minerals

Electrolytes such as sodium, chloride and potassium are among dietary factors known to be related to water intake by pigs. Sodium and chloride associate as NaCl, or table salt, a prevalent additive in swine diet formulation. In pigs, adding dietary salt at a rate of 1 g/kg increases the average daily water intake by 0.10 – 1.0 l/d (Mroz et al., 1995). Hagsten and Perry (1976) found that water intake decreased by 10-20% on a low salt diet compared to one containing adequate salt. Electrolytes can be added to the diet in forms other than salt; supplementation with sodium bicarbonate (2.6%) and potassium carbonate (3.0%) had the effect of increasing urine volume by 0.63 and 1.03 l/d respectively (Patience et al., 1986).

Water Consumption and Fibre

Fibre is hygroscopic in nature; in other words, fibre in the diet has the effect of drawing water as it passes through the digestive tract (Brooks and Carpenter, 1990). In addition, feedstuffs containing a large proportion of fibrous material pass more quickly through the digestive tract, allowing less time for water to be reabsorbed into the body's tissues. These factors combine to increase the animal's requirement for water when a diet high in fibre is provided.

Summary

Dietary factors play a key role in the water use patterns of pigs. To avoid deprivation and related impaired performance due to individual or environmental factors, animals in commercial pig barns are usually given free access to water. Efforts to reduce water wastage have the potential to minimize the impact that large scale pig production units have on the supply of groundwater, a valuable natural resource. Manure produced by intensive hog farming contributes to operating costs related to the storing and hauling of slurry. A clear understanding of the relationship between diet composition and water intake therefore has practical implications for minimizing costs and addressing environmental concerns associated with large scale pork production.

Acknowledgements

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

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Eliminating water wastage can help minimize environmental impact and save money.

WATER INTAKE AND WASTAGE BY GROWER/FINISHER PIGS AT NIPPLE DRINKERS

Yuzhi Li and Harold. W. Gonyou

Summary

The water intake of pigs is not well known since a large amount of water is wasted from drinkers. A study was conducted to determine water intake and wastage by grower/finisher pigs at nipple drinkers. Actual water intakes of growing and finishing pigs are 4.0 and 5.9 l/d, respectively. The pigs wasted 25% of the water flowing from the nipple drinkers. High nipple flow rates increase water spillage of pigs.

Pigs waste 25% of water from nipple drinkers.

Introduction

Among nutrients, water is required in the greatest amount but has received the least attention. Water intake of grower/finisher pigs has been reported to range from 1.9 to 6.8 l/d, depending on body weight and feed intake. However, most 'water intake' reported in the literature is water disappearance from drinkers, including water wastage, rather than water actually consumed by the animal. A study was conducted to determine actual water intake and wastage of grower/finisher pigs at nipple drinkers. The effect of nipple flow rate on water spillage was also included in the study.

Experimental procedures

Six pens of eight pigs were tested at two stages, mean body weight of 53±5 kg for growers and 72±6 kg for finishers. The pigs were fed pelleted feed ad libitum at room temperatures of 20~25°C. The nipple drinker in each pen was 5 cm higher than the shoulder height of the smallest pig. Daily feed intake, water intake, and water wastage in each pen were measured at a nipple flow rate of approximately 700 ml/min. Drinking speed and water spillage were assessed for 4 pigs in each pen after four hours without water, at nipple-flow rates of 651, 1003, 1226 and 2080 ml/min.

Results and discussion

Water intakes (disappearance – wastage) of the growers and finishers were 4.0 and 5.4 l/day, respectively (Table 1). When expressed in terms of feed intake, water intakes at the two stages were identical. Water wastage was 1.3 and 1.9 l/day for the growers and finishers, respectively, accounting for 25% of the total water disappearance for both growers and finishers. This is lower than what (40~60%) has been estimated on commercial farms. Proper height and flow rate of the nipple drinkers in the current study could contribute to the improvement in water wastage. Drinking speed of pigs was increased to 1422 ml of actual water intake/min at the nipple flow rate of 2080 ml/min (Fig. 1). Although the pigs increased drinking speed, water spillage was higher at the high flow rate than at the low flow rate (23.2% at 2080 ml/min vs. 8.6% at 650 ml/min, Fig.2).

Implications

Growing and finishing pigs waste 25% of water from well-managed nipple drinkers. It seems that water wastage could be reduced by properly adjusting nipple height and flow rate.

Acknowledgements

Funding for this project was provided by an NSERC/AAFC grant. Strategic program funding was provided by Sask. Pork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund.

Table 1. Water intake and wastage of growing and finishing pigs*

Period	Grower	Finisher	SE	P <
Body weight, kg	52.6	71.9	0.84	--
Feed intake, kg/d	1.69	2.54	0.09	--
Water disappearance, l/d	5.29	7.31	0.23	0.01
Water intake, l/d	4.00	5.38	0.17	0.01
Water intake/feed intake, l/kg	2.43	2.13	0.12	NS
Water wastage, l/d	1.29	1.93	0.11	0.01
Water wastage/disappearance, %	24.2	26.3	1.08	NS

*Least square means (n=6). NS=no significant difference (P > 0.05).

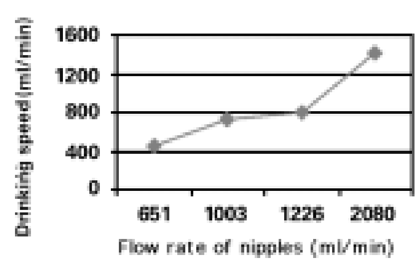

Fig.1. Drinking speed of grower/finisher pigs at different nipple flow rates.

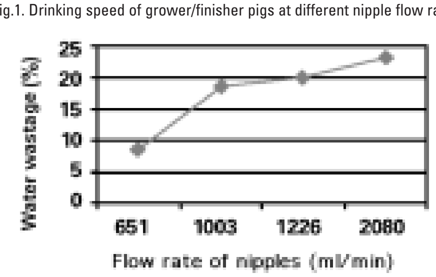

Fig. 2. Water wastage of grower/finisher pigs at different nipple flow rates.

EFFECT OF FEED PRESENTATION ON THE FEEDING BEHAVIOUR OF GROWER/FINISHER PIGS

Kimberly A.M. MacDonald, and Harold W. Gonyou

Introduction

Recent research suggests the once standard five pigs per feeder space underestimates the actual carrying capacity of most modern feeder designs. The maximum number of pigs that can be fed from a single feeder space should be highly correlated with the eating speed of the animals. The feeding behaviour of pigs is influenced by many factors such as, but not limited to, competition, feed type (pellet vs. mash), presentation (dry vs. wet/dry or liquid feeding systems) and pig size. In this study, we examined the effect of feed type and presentation on the eating behaviour of grower/finisher pigs. Furthermore, we attempted to determine if these effects would then translate into higher stocking densities of the feeder (based on percentage of capacity of the feeder).

Methods

Experiment One. Pigs were randomly assigned to each of four treatments: dry mash (DM), wet/dry mash (WM), dry pellets (DP) and wet/dry pellets (WP), fed from a single space feeder. Each pen contained six barrows and six gilts, and the average weight in each pen was similar. Feed was weighed as it was added to the feeder; pigs and any remaining feed were weighed every two weeks. When the pigs were small (35-45 kg), the pens were videotaped for two consecutive 24-hour periods in order to determine total duration of eating. Video recordings and analysis were repeated when the pigs were large (90-100kg) to determine the effects of size on time spent eating and if this effect was consistent across the treatments.

Experiment Two. Using data from experiment one, an estimate of the number of pigs required to create various levels of feeder space utilization (stocking density) under each previously outlined feeding condition was calculated. Grower pig numbers were based on small data, while finisher phase numbers were calculated using large pig data. Stocking densities examined were standard (12 pigs/pen), 95, 110 and 125% of feeder capacity in the grower phase and 80, 102.5 and 125% of capacity in the finisher phase. Pigs stayed in the grower phase for six weeks before being randomly reassigned to the finisher phase treatments, where they stayed for four weeks. Video recordings were taken when the pigs were 35-45kg in grower and during the third week of finisher. Feed was weighed as it was added to the feeders, and pigs were weighed regularly.

Results

Experiment One. Pigs fed a DM diet spent significantly more time at the feeder than those fed WM, DP or WP (refer to table 1). There was no significant difference in total duration of eating among WM, DP and WP fed pigs. ADFI was similar among treatment groups. However, ADG was lower in DM fed pigs as compared to WM or WP treatments. DP pigs had intermediate gains (see table 1). Large pigs spent less time at the feeder than small pigs.

Pigs on a dry mash diet spent more time at the feeder than those on other diets.

Experiment Two. Comparisons between groups of similar size (12 pigs in grower and 18 pigs in finisher) revealed results similar to those found in experiment one. In the grower phase, DM pigs spent more time at the feeder than DP, WM and WP fed pigs (98.3 vs. 87.6 vs. 61.2 vs. 80.0 min/pig/day). Also, DM pigs gained less than WM, DP or WP fed pigs (748 vs. 833 vs. 799 vs. 792 g/day). Pigs fed a WM diet had higher ADFI, while no significant differences were found in ADFI among DM, DP and WP fed pigs (2.15 vs. 1.91 vs. 1.86 vs. 1.88 kg/pig/day). Similar trends were apparent in the finisher phase (see Table 2).

As stocking density increased, time spent eating per pig decreased in both grower and finisher phases, regardless of feed type or presentation. Likewise, ADG and ADFI had a tendency to decrease as stocking density increased, particularly in treatments that exceeded 100% of capacity. However, the point at which production values significantly decreased varied based on feed type and presentation.

Conclusions

Feed type (mash vs. pellets) and presentation (dry vs. wet/dry) have major affects on swine eating behaviour and, in turn, can influence productivity. Pigs fed dry mash diets spend more time eating, however this effect can be counteracted by the addition of water, such as in a wet/dry feeding system. This same effect does not appear to apply to wet/dry versus dry pellets, which could be due to a variety of factors, such as palatability or simple mechanics. These results are noticeable in both grower and finisher phases, suggesting that the disadvantages and advantages associated with feed type and presentation are persistent, even with the increased eating speed of larger animals.

Stocking density (based on percentage of capacity) of the feeder also has a strong influence on time spent eating per pig, ADFI and ADG. As stocking density increased there was a general trend for ADG and ADFI to fall, regardless of feed type and presentation (see figure 1 for an example). In the grower phase, the maximum number of pigs that could be fed from a single feeder space without a significant decrease in ADG and ADFI was 15, 19, 20 and 21 for DM, WM, WP and DP feed respectively. While in the finisher phase, 14, 18 and 23 pigs could be fed DM, WM and DP respectively, from a single feeder space. There was no intermediate group size for WP fed pigs in the finisher phase, but at least 18 pigs can be fed from a single feeder space and maintain good ADG and ADFI.

Acknowledgments

Strategic program funding provided by Sask Pork, Manitoba Pork and Saskatchewan Agriculture and Food Development Fund. Additional funding for this research was made available by the Alberta Agriculture Research Institute and the Alberta Pork Producer Council.

Maximum stocking density depends on feed type and presentation.

Table 1. Overall effect of feed type and presentation on ADG, ADFI and Total Duration of Eating (Experiment One)

Feed Type	Presentation	ADG (kg)	SEM	ADFI (kg)	SEM	Total Duration of Eating (min/pig/day)	SEM
Mash	Dry	0.792[a]	0.023	2.50	0.145	106.10[a]	2.91
Mash	Wet/Dry	0.903[b]	0.026	2.38	0.145	68.04[b]	2.91
Pellet	Dry	0.868[b]	0.021	2.48	0.145	58.79[b]	2.91
Pellet	Wet/Dry	0.899[b]	0.025	2.37	0.205	59.70[b]	2.91

[ab] ; $p < 0.05$

Table 2. Overall effect of feed type and presentation on ADG, ADFI and Total Duration of Eating - Finisher Phase (Group size = 18 pigs) (Experiment Two)

Feed Type	Presentation	ADG (kg)	SEM	ADFI (kg)	SEM	Total Duration of Eating (min/pig/day)	SEM
Mash	Dry	0.739[b]	0.046	2.31[b]	0.139	78.6[a]	12.35
Mash	Wet/Dry	0.955[a]	0.046	2.93[a]	0.139	69.7[b]	12.35
Pellet	Dry	0.867[a]	0.045	2.51[a,b]	0.139	68.9[b]	12.35
Pellet	Wet/Dry	1.02[a]	0.044	2.71[a,b]	0.139	65.5[b]	12.35

Numbers with different superscripts have $p<0.05$

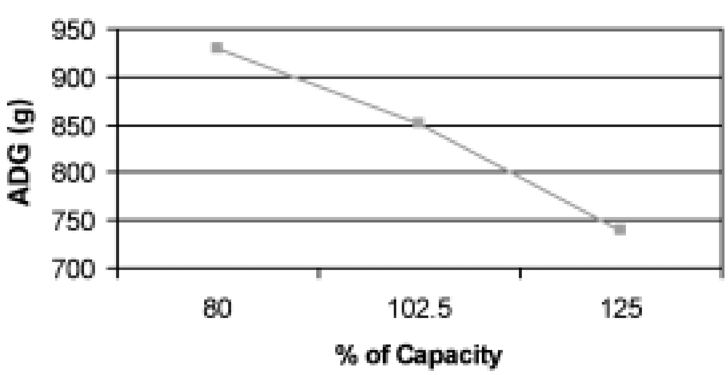

Figure 1. Effect of stocking density on ADG of DM fed pigs in the Finisher Phase

SEQUENTIAL ANALYSIS OF BELLY NOSING OF EARLY WEANED PIGS

Yuzhi Li, K. Getson, C. Peterson and H.W. Gonyou

Summary

The causal factors of some anomalous behaviours frequently found in early weaned piglets are not well known. A study was conducted to assess the motivation for belly nosing in piglets weaned at 12-14 days. The results showed that belly nosing is more associated with social interaction rather than eating or drinking behaviour.

Introduction

Segregated early weaning improves disease control and performance in pigs. However, it has been linked to an increased incidence of anomalous behaviours, which raises welfare concerns. A common anomalous behaviour is belly nosing, but the key causal factors of this behaviour are not clear. A study was conducted to assess the motivation for belly nosing by examining relationship of belly nosing with other behaviours of segregated early-weaned pigs.

Experimental procedures

Eight pens of 10 pigs, weaned at 12-14 days of age, were videotaped for 24 hours on day 7 post-weaning. Behavioural time budgets and partial correlations for each pig were determined by scan sampling at five minute intervals. Twenty-five belly-nosing events identified by the scan sampling were randomly selected from each of four pens. These events were analyzed by continuous observation of the nosing pig, beginning five minutes before belly nosing began and concluding five minutes after nosing ended. A sequential analysis was conducted to assess the motivation of belly nosing. Behaviours that occur in sequence, that is, one is typically followed by another, are believed to share similar motivation. A Chi-square analysis was performed for each two-event sequence to determine whether the observed frequencies of any of the sequences deviated from their expected values.

Results and discussion

On day 7 post-weaning, the piglets spent the majority of the time lying and standing (Table 1). The average time spent belly nosing was 2.4% of total time. About 80% of the pigs were belly nosing, with approximately 20% spending over an hour per day on this behaviour (Fig. 1).

Belly nosing was negatively correlated with eating ($r=-0.35$, $P<0.05$) and lying ($r=-0.58$, $P<0.05$), but positively correlated with standing ($r=0.28$, $P<0.05$). This indicates that pigs that spent more time lying and eating likely spent less time belly nosing. The average duration of the nosing segment was 538 seconds, during which the focal pig spent 65.8% of time belly nosing with a mean duration of 64 seconds for each nosing incidence. The two-event sequential analysis (Fig. 2) indicated that social interaction and belly nosing frequently occurred in sequence. On the other hand, belly nosing was not directly linked with eating or drinking. The behaviours occurring in sequence are expected to have a common causal factor, or the first stimulates the second. Sequences occurring rarely are likely to consist of behaviours with different causal factors. These results indicate that motivation for belly nosing is more closely associated with social interaction, rather than eating or drinking.

Belly nosing is more directly linked to social behaviour rather than eating and lying.

Implication

Incidence of belly nosing is higher in early-weaned piglets. Pigs spent more time eating and lying likely are less belly nosing. However, motivation of belly nosing is more associated with that of social interaction rather than that of eating or drinking. The present results indicate that methods to reduce belly nosing in early-weaned pigs may include manipulating social behaviour, as well as stimulating lying and eating.

Acknowledgements

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

Table 1. Behavioral time budget of early weaned piglets on Day 7 post weaning*

Behavior	Time budget (% of time)	SE
Lying	76.9	1.36
Standing	12.7	0.73
Drinking	0.4	0.11
Eating	5.3	0.77
Belly Nosing	2.4	0.82
Being nosed	2.2	0.76

*Means of 8 pens of 10 pigs.

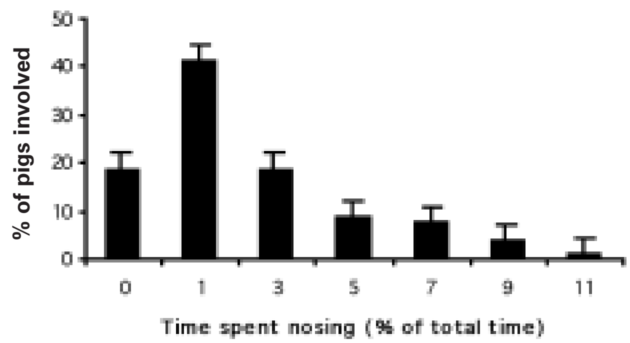

Fig.1. Distribution of belly nosing in individual piglets weaned at 14 days of age on Day 7 post weaning.

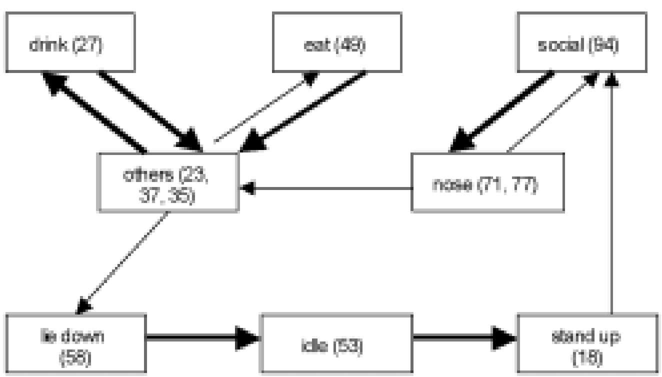

Fig.2. Chi-square analysis: Two-event sequences with observed frequencies higher than the expected means. Numbers in the bracket are the observed frequency of the first event going to the second event, dark and light arrows mean $p < 0.01$ and $p < 0.05$, respectively.

BEHAVIOURAL DIVERSITY IN GROUPS OF JUVENILE PIGS

Stephanie M. Hayne and
Harold W. Gonyou

Introduction

Understanding behavioural diversity is important for commercial production, animal behaviour and animal welfare. One interpretation of individual differences in behaviour is that these represent different strategies for coping with a challenging environment. For example, one pig may respond to a crowded feeder by becoming aggressive, while another adopts the strategy of waiting until the feeder is vacant. There is variability in pig performance, and this may be related to individual behavioural characteristics. The objective of this study was to determine the primary characteristics that distinguish individual pigs.

Methods

Eighty-nine pigs (nine litters) were followed from birth until eight weeks of age. In addition to determining each piglet's average daily gain and assessing health and injuries, we determined their general activity levels in terms of time spent eating, drinking, lying, standing, playing, fighting, displacing, and chewing/belly nosing on penmates. We also determined how consistent each piglet was in using their primary teat while suckling. While the pigs were in the nursery, we exposed each pig to three behavioural test situations. During a restraint test, we gently held each pig on their back in a V-trough for one minute and evaluated their degree of resistance. In an ease of movement test, each pig was evaluated on their willingness to move down a novel corridor. The final test involved using a novel arena (a circular arena consisting of six solid plywood walls) in which we evaluated each pig's willingness to approach and interact with a human and a novel object.

Results

Three primary 'personality' factors were identified. These factors distinguished the pigs based on their response to humans, their ease of movement down a novel corridor and their involvement in social displacement activities. The specific variables that contributed to the formation of each factor are presented in Table 1. The factor relating to the pig's response to humans was correlated with average daily gain. Pigs that were more cautious had a tendency to be less active and gain more weight.

Table 1. Variables that contributed to the formation of each factor

Factor 1	Factor 2	Factor 3
Time taken to approach a human	Time taken to move down a novel corridor	Involvement in social displacement activities
Time to interact with a human	Subjective score of pig's willingness to move	(pushing/biting another pig, causing recipient to move)
Time spent within 0.5 m of a human	Degree of resistance during restraint	
Number of interactions with a human	Time spent standing	
Time taken to interact with a novel object	Time spent lying	
Time spent standing		
Time spent lying		

Figure 1. Example of the restraint test

Conclusions

Based on the variables that loaded onto each factor, it appears that factor 1 is related to level of confidence, factor 2 is related to level of exploration, and factor 3 is related to level of aggression. This study will be expanded to investigate the effect different re-grouping strategies (based on weight, behaviour or random) have on 'personality' traits, and form the basis of recommendations to the industry about the most appropriate grouping strategies to use.

Further study is required to determine the best grouping strategies.

Acknowledgements

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

PAMI BUILDS TANKER TRUCK INJECTOR FOR RESEARCH AND DEMONSTRATION

By Gord Hultgreen, PAMI

Introduction

With a large land mass and low rural population, Saskatchewan has the potential to greatly expand pork production. The objective of the project was to develop a liquid manure application system to efficiently apply swine manure to research and demonstration sites throughout Saskatchewan.

PAMI's tanker truck injector system is based on a Mack tractor unit with a stretched frame.

Project Description

After studying a number of alternatives, PAMI decided that the best option for applying swine manure to research and demonstration plots was to develop a truck-based system with vacuum/pressure tank. The truck would have the capability of traveling long distances, be able to pump swine manure directly from the earthen manure storage to the truck and be able to apply swine manure using either low or high disturbance injection.

Manure Truck Design Parameters

The truck is a 1994 Mack semi-trailer truck with the fifth wheel removed and frame stretched to handle a large manure tank. A low speed auxiliary transmission was added to allow field ground speeds as low as 1 mph. Wide tires were added to the front axle to improve in field flotation. A computer controlled tire pressure system is used to lower tire pressure in the field and on secondary roads to reduce field compaction and road damage.

Mounted on the truck is a 2700 imperial gallon pressure/vacuum tank that uses a hydraulic powered vane pump for pressure or vacuum. Down force on the tool bar can be adjusted for constant injection depth.

A three-rank, 10-foot wide toolbar is attached to the back of the truck with a parallel link system. The toolbar can be equipped with high disturbance shanks and shovels or with low disturbance disc systems for operation in conventional or zero till conditions as well as in pasture. Row space can be changed to accommodate project requirements.
A GreenTrac distribution manifold is used for even manure distribution over a wide range of manure application rates.

A gas powered high-pressure washer and 100 Imperial gallon tank is attached to the truck for cleaning and disinfecting.

A Dicky-John Land Manager GIS/GPS system controls the manure application rate. Ground speed is monitored by radar and a differential GPS receiver supplies field location.

Results and Conclusions

The truck injector system was completed in the fall of 2000 and all manure application research plots were applied using the new machine. Both high disturbance and low disturbance plots were applied successfully with the new system. A few modifications to the toolbar have been made to improve field performance.

Implications

The injector truck is now in service and is used for all swine manure plot research conducted by PAMI in Saskatchewan. Discussions are in the planning stage with Sask Pork for expanding the use of the machine by conducting swine manure application demonstrations in addition to the research activities.

Acknowledgements

Strategic funding was provided by Sask Pork, and Saskatchewan Agriculture and Food/Agriculture Development Fund.

OPTIMIZING OF A SPRINKLING SYSTEM USING UNDILUTED CANOLA OIL FOR DUST CONTROL IN PIG BUILDINGS

S.P. Lemay [1], L. Chénard [1], E.M. Barber [2] and R. Fengler [1]

Background

Swine producers are exposed to high dust levels in pig barns and different methods have been tested for controlling dust concentrations over the last decade. Oil sprinkling/spraying has proven to be one of the most effective methods so far for reducing dust concentration in pig buildings. In most of those previous experiments, the oil had to be manually applied once or twice a day. The swine industry has not easily adopted oil application technology because of the very intensive labour required for manual sprinkling of oil and because of its perceived high cost. An oil sprinkling system has been designed to control dust levels in pig buildings using undiluted crude canola oil and proved to be effective in reducing dust in tests performed over a two-week period at PSCI (Lemay et al., 1999).

Objectives

The objectives of this project were to provide more information on the optimum oil application rate that could be used in grower-finisher barns, and to verify the necessity of sprinkling operator walkways and applying a booster dosage every two weeks.

Oil sprinkling system installed in a commercial room at PSCI.

Experimental procedure

The experiment was conducted using the system developed by Lemay et al. (1999). The system was installed in a grower-finisher room at PSCI and only the spray nozzles above the pens were used so that no sprinkling occurred on the walkways.

The experiment was conducted in two identical rooms, one equipped with the sprinkling system and the other one acting as a control. Each room housed 72 pigs in six pens; these animals entered the rooms at a same average weight and at the same time and they were fed the same diet. The system provided 40 ml of oil/m2-day on the first two days, 20 ml of oil/m2-day on the next two days, and 5 ml of oil/m2-day on every day for the rest of the experiment. No booster application was performed every other week as suggested by Zhang et al. (1995). Dust particle counts and total dust mass concentration were measured in both rooms during the seven-week period.

Results

Over the seven-week period, the dust mass concentration was reduced by 87% comparing the room sprinkled with oil to the control room where no oil was applied (Figure 1). As shown on Figures 2 and 3, inhalable (>0.5 µ) and respirable (0.5 to 5.0 µ) dust particle counts were lowered by 90 and 86%, respectively.

When compared with the oil application rates recommended by Zhang et al. (1995), similar dust reduction results were obtained by using 36% less oil (18.5 L compared to 29.0 L of canola oil) over the seven-week period of the experiment. The system was effective in replicating previous dust reduction data collected with automated and manual systems and could be automated to control dust levels in grow-finish barns.

Automated oil sprinkling systems can reduce dust levels by 87%.

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Acknowledgements

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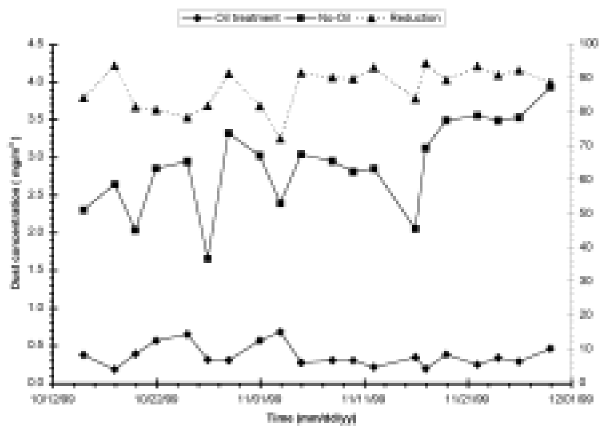


Figure 1 Dust mass concentration in both control and oil treated rooms from October 15th to November 29th, 1999.

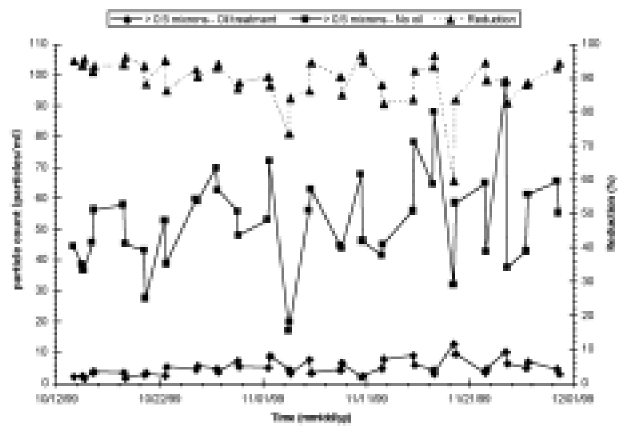


Figure 2 Inhalable dust particle counts in both control and oil treated rooms from October 15th to November 29th, 1999.

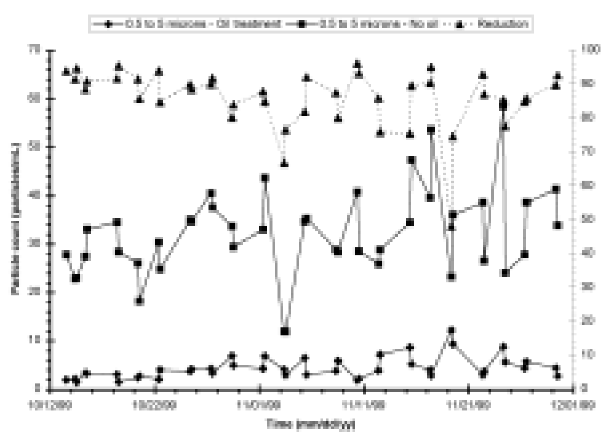


Figure 3 Respirable dust particle counts in both control and oil treated rooms from October 15th to November 29th, 1999.

TWO-AIRSPACE BUILDING DESIGN FOR REDUCING ODOUR AND GAS EMISSIONS FROM GROWER – FINISHER BARNS

S.P. Lemay [1], H.W. Gonyou [1], J. Feddes [2], E.M. Barber [3] and R. Coleman [4]

Air quality in the barn and in its vicinity

Odour and gas emissions from swine operations can be a nuisance to nearby residents. In Canada, most pig barns have outside manure storage resulting in two odour sources on the production sites: the building and the manure storage facility. By keeping the manure inside the building, the nuisance sources would be reduced to only one. A two-airspace building concept where pigs would dung in an enclosed dunging area (EDA) above the slats could result in an improvement of the barn air quality as odours and gases from dunging and the manure itself would be contained inside the EDA. By extracting part of the ventilation rate through the EDA and treating this air with a biofilter, the overall emissions from a swine operation could be reduced.

Objectives

The objectives of the project were:

- To construct an EDA that will:
  - -be consistently used by the pigs.
  - -minimise odour/gas transfer to the pig/worker airspace.
- To observe the pig behaviour in a pen equipped with an EDA.
- To design and test four types of opening for the EDA:
  - -no door, solid door, strip curtain and air curtain.
- To construct and evaluate a two-airspace ventilation system.
- To investigate the use of biofiltration for odour removal from EDAs.
- To measure odour and gas emissions from a feeder barn provided with EDAs and biofilters.

This project was conducted at two locations: at Prairie Swine Centre (PSCI) for the engineering development of the EDA concept and pig behaviour analysis, and at the University of Alberta for the development of the biofilter and its implementation with the EDA. This article summarizes the work completed at PSCI.

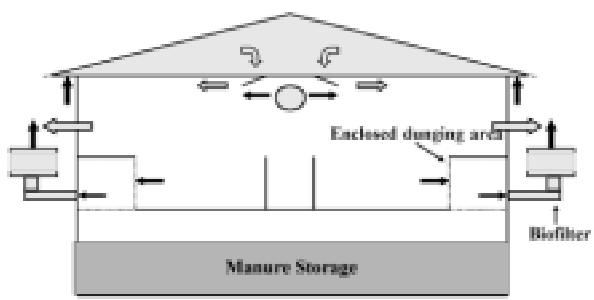
The development of the two-airspace concept

The EDA design was established through different steps to analyse the different components of the new concept and their impacts on the pigs.

- Air containment tests were performed in laboratory at the University of Saskatchewan to verify the potential of the EDAs for gas containment.
- Behavioural studies of the pigs using open EDAs were conducted at PSCI.
- Engineering modifications to the EDA design were implemented to help controlling pig dunging behaviour and to improve gas containment.

The most promising EDA was selected for thorough in-barn testing at PSCI and was equipped with:

- a full strip curtain on the whole width of the pen that reduced gas containment but greatly improved pig usage of the EDA and cleanliness of the pens;
- bars that were laid on the slats and intermittent water sprinkling used for a few days to discourage pigs from sleeping in the EDA.



Schematic of the two-airspace building design

The most promising design featured a full strip curtain, bars on the slats and intermittent water sprinkling.

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The EDA design implemented at PSCI and tested with full strip curtains

Results

The following figures show the impact of the two-airspace concept on odour threshold and ammonia concentrations for both a conventional grower-finisher room (control room) and a similar room equipped with EDAs (treatment room). Air samples were taken in the middle of the rooms and also directly inside the EDA. Over the four sampling periods, odour threshold measurements showed a 20% reduction in the treatment room compared to the control room and no consistent differences were measured in the EDA. The ammonia concentration was reduced by 40% in the treatment room compared to the control room. However, the concentration in the EDA was more than double what was measured in the treatment room which demonstrated that a good gas containment could be provided by the two-airspace concept. No consistent differences were observed for the hedonic tone of the odour and the carbon dioxide concentrations.

Conclusions

Odour and ammonia concentrations were reduced using the full curtain EDA that was developed for the two air-space building design:

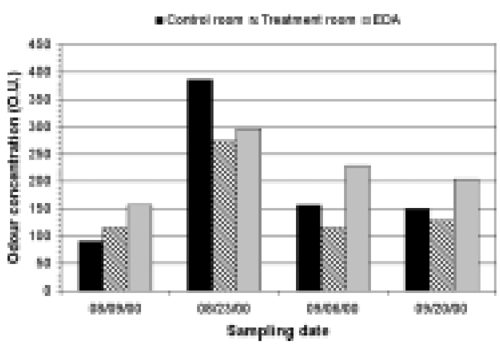
- Reductions of 20 and 40% were measured for odour threshold and ammonia, respectively;
- No difference were observed on the hedonic tone and the carbon dioxide concentrations.

Further steps have to be completed for this project:

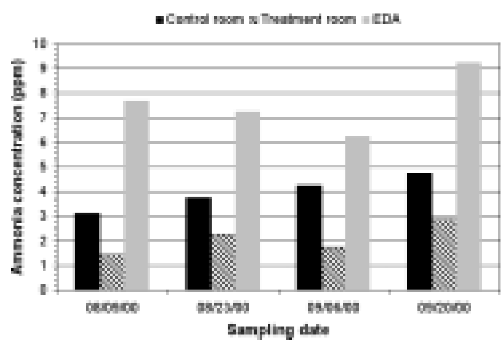
- A full data analysis of the pig behaviour and odour and gas measurements based on the results obtained at PSCI;
- The experiment with a room equipped with EDAs and biofilters at the University of Alberta.

Acknowledgements

Canada Alberta Hog Industry Development Fund, Alberta Agriculture Research Institute and strategic program funding provided by SaskPork, Alberta Pork, Manitoba Pork and Saskatchewan Agriculture and Development Fund.



Odour concentration measured with the full curtain EDA (PSCI)



Ammonia concentration measured with the full curtain EDA (PSCI)

OIL SPRINKLING AND DIETARY MANIPULATION TO REDUCE ODOUR AND GAS EMISSIONS FROM GROWER / FINISHER BUILDINGS – LABORATORY SCALE EXPERIMENT

S. Godbout [1], S.P. Lemay [2], R. Joncas [1], J.P. Larouche [1], D.Y. Martin [1], J.F. Bernier [3], R.T. Zijlstra [2], L. Chénard [2], A. Marquis [3], E.M. Barber [4] and D. Massé [5]

Background

Odours emitted by the ventilation system of hog barns are significant contributors to the total farm odour emissions as this emission source is more continuous compared to odours emitted during storage or land application of manure.

Hypothesis and objectives

The hypothesis of this project is that a combined engineering and nutrition strategy consisting of canola oil sprinkling and a specific animal diet can result in a significant reduction of odour and gas emissions from swine buildings. This strategy is expected to significantly reduce the potential impact of pig barns on their surroundings. The first part of this three-year project was completed in Deschambault (Québec) and results on pig performance, ammonia and odour emissions are presented herein.

The specific objectives for this first phase of the study were:

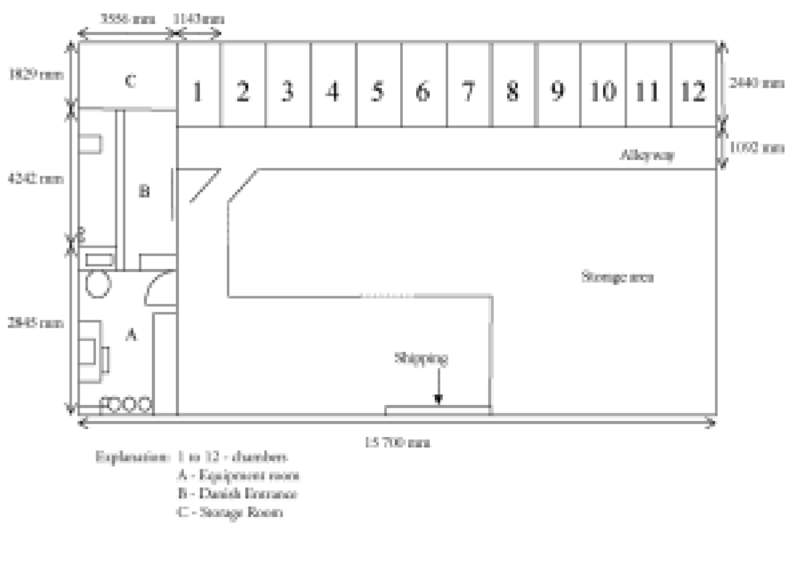
- To determine the interaction of four canola oil application rates (0, 10, 20 and 30 ml/m2 day) and three experimental diets (control diet (C) based on corn with an18% protein content; diet LP containing 16% protein; and diet LP-FC containing 16% protein and fermentable carbohydrates [15% soybean hulls]) on odour, dust and gas (CO_2, NH_3, H_2S) emissions from laboratory scale pig chambers.
- To select a combination of application rate and experimental diet that optimize odour, dust and gas emissions reduction.
- To determine the interaction of canola oil application rates and experimental diets on the chemical composition of the manure.

Experimental procedure

Twelve laboratory scale chambers were built to allow for each combination of experimental treatments (four oil application rates x three diets) to be tested during each replication of the experiment. Measurements were collected over three weeks for each of the four trials providing four replicates for each treatment combination. Each chamber housed four castrated males that had an initial weight of 56 ± 0.5 kg and a final weight of 80 ± 0.5 kg.

Temperature, relative humidity, total dust mass, CO_2, NH_3, and H_2S concentrations were monitored on a continuous basis. Air samples for odour analysis were collected once a week and sent to the olfactometry laboratory of the AAFC - Dairy and Swine Research and Development Centre at Lennoxville, QC.

Schematic of the experimental chamber set-up



[1] Institut de recherche et de développement en agroenvironnement (IRDA), Deschambault, Québec, Canada
[2] Prairie Swine Centre Inc. (PSCI), Saskatoon, Saskatchewan, Canada
[3] Université Laval, Québec, Québec, Canada
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Results and Discussion

Animal performance

Table 1 presents the experimental results on pig performance. Overall, the pig average daily gain and feed intake were 1.07 kg/day and 2.66 kg/day, respectively. The overall feed conversion (feed/gain) averaged 2.49 representing a better performance than what is typically achieved in commercial barns. No significant difference in pig performance among the three diets was observed (P>0.05).

Table 1 Average animal performance over the entire experiment (from 58 to 80 kg)

Oil application rate(ml/m^2-day)	Diet	Average daily gain (kg/day)	Average daily feed intake (kg/day)	Feed conversion (feed/gain)
0	C	0.96	2.59	2.34
	LP	0.97	2.43	2.51
	LP-FC	1.10	2.69	2.48
10	C	1.04	2.64	2.58
	LP	1.16	2.83	2.49
	LP-FC	1.09	2.61	2.43
20	C	1.10	2.76	2.55
	LP	1.11	2.71	2.47
	LP-FC	1.07	2.71	2.56
30	C	1.01	2.47	2.49
	LP	1.10	2.70	2.48
	LP-FC	1.16	2.74	2.39
Average		1.07	2.66	2.49

Ammonia emissions

Table 2 indicates that diet formulation significantly reduced NH_3 emission rates. In average, LP and LP-FC diets provided a 21 and 38% reduction in NH_3 emissions from the chambers compared to the control diet. Based on these results, manipulating pig diet appears to be an effective strategy for the reduction of NH_3 emission rates from swine buildings.

Table 2 Ammonia emission rates with the experimental diets and oil application rates

Diet	NH_3 emission rate (mg/s)			
	Oil application rate (ml/m^2-day)			
	0	10	20	30
C	0.40 a	0.36ae	0.32 de	0.36 ae
LP	0.28bd	0.28bd	0.28 bd	0,30 bd
LP-FC	0.22c	0.22cf	0.26 bf	0.20 c

Note: Averages followed by a different letter are significantly different (*P*<0.05).

Contrary to what was suggested in the initial working hypothesis, application of canola oil on the floor and the pigs did not decrease NH3 emission rates from the chambers (P>0.10).

Odour emissions

As presented in Table 3, the diet treatments without any oil application had no impact on odour emissions as no significant difference was observed. With the C diet, odour emissions were significantly reduced by 20 and 13% with oil applications of 10 and 30 ml/m2-day, respectively. The reductions in odour emissions between both application rates (10 and 30 ml/m2-day) for the C diet were not different.

Phase II of this project will involve the testing of the most promising combination of oil application rate and experimental diet and it will be completed at PSCI in commercial rooms over the year 2001.

Table 3 Odour emission rates with the experimental diets and oil application rates

Diet	Odour emission rate (OU/s)			
	Oil application rate (ml/m^2-day)			
	0	10	20	30
C	30acd	24be	28bde	26e
LP	27abde	38c	30abd	36d
LP-FC	23abde	30	33	30ae

Note: Averages followed by a different letter are significantly different (P<0.05).

Acknowledgments

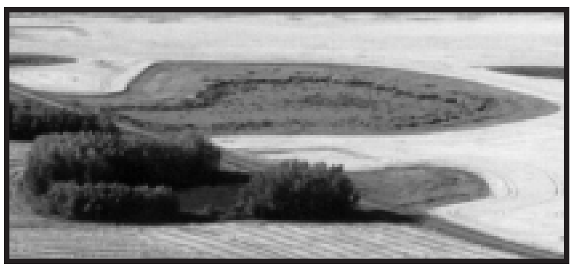
The authors wish to acknowledge the funding provided for this project by the Canadian Pork Council and Agriculture and Agri-Food Canada through the HEMS program. Technical support was provided by the Centre de Développement du Porc du Québec, the Institut de Recherche et de Développement en Agro-Environnement (IRDA) and the Prairie Swine Centre Inc.

BASELINE ENVIRONMENTAL DATA COLLECTION FOR RESEARCH AND PRODUCTION FACILITY

E. M. Barber [1], C. P. Maule [1], T.A. Fonstad [1], S.L.Perih [1], L.J. Ingram [1], D.E. Meier [1], and S.P. Lemay [2]

Introduction

Potential environmental impacts associated with intensive livestock operations are recognized as a major factor limiting the establishment of these operations in the Prairies. To determine the true environmental impacts of an intensive livestock operation, one must compare the change in environmental conditions before and after the facility is constructed and in operation. The PSCI Elstow Research Farm is included in this study.



Potential environmental impacts are a limiting factor for intensive livestock operations.

Objectives

To collect environmental data for a "pre-operation" analysis of the surrounding area including air, soil, and water. This includes collection of odour samples, groundwater samples, well water samples, surface water samples, and soil samples.

Methodology

Task I - Baseline Odour Data Collection:
Odour collection will involve data collection within 2.4 km (at 600, 1200, and 2400 m) of the proposed facility and a selected group of neighbouring farmyards.

To ensure that data collected includes annual variations in weather and activity, the samples will be collected in February, May, August, and November for a total of two years.

Task II - Baseline Groundwater Quality Data Collection:
Installation of piezometers around the earthen manure storage and barn will give the geological cross-section of the area, the horizontal gradient of the water table, and shallow groundwater chemistry.

Task III Baseline Well Water Data Collection:
Approximately 10 of the surrounding private water wells were sampled by PFRA to determine current water quality. A complete chemical analysis of the well water will also be done at the end of the project.

Task IV - Baseline Surface Water Data Surface water bodies will be identified and monitored for current water quality prior to the first manure application. Samples will be collected three times a year for two years.

Task V Baseline Soil Data Collection:
A soil survey will establish the soil characteristics prior to manure production. The soil survey (through field descriptions of soil, lab analysis, and aerial photo interpretation) will establish soil type, soil chemistry, and soil fertility prior to manure production. Soil cores will be taken to determine the physical and chemical analysis (texture, ions and nutrients).

Results Expected

An environmental assessment of the areas prior to facility operation will be established. All future research at the sites will refer to the baseline data established by this project.

We would like to acknowledge the contributions of Saskatchewan Agriculture Development Fund and the Prairie Farm Rehabilitation Association.

True environmental impacts must compare conditions before and after a facility is built.

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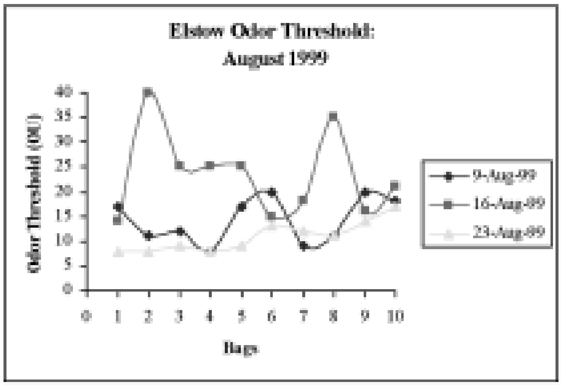
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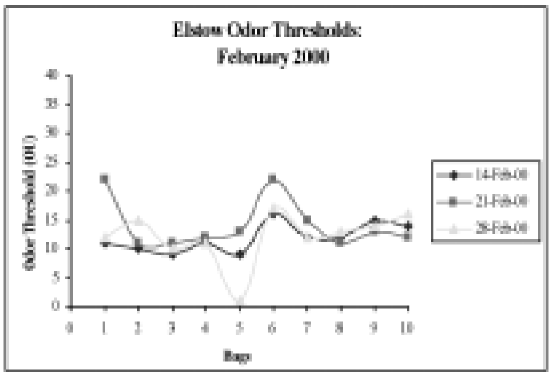
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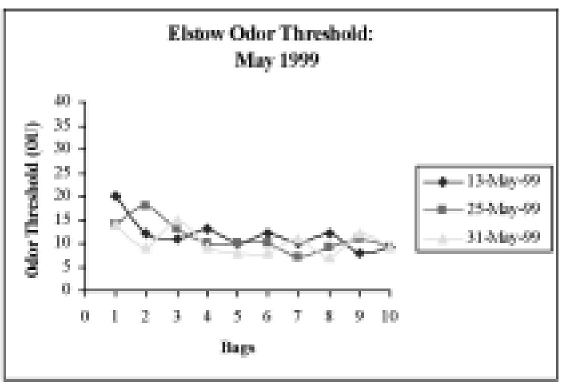
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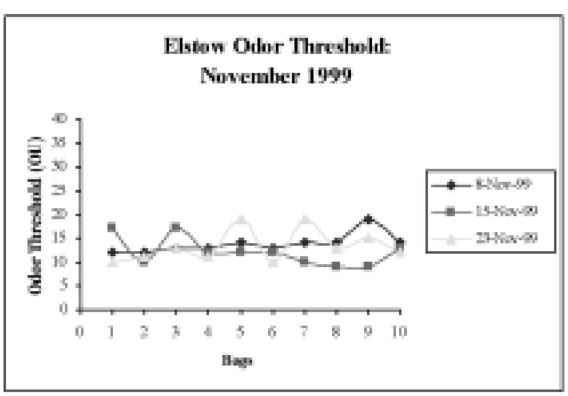
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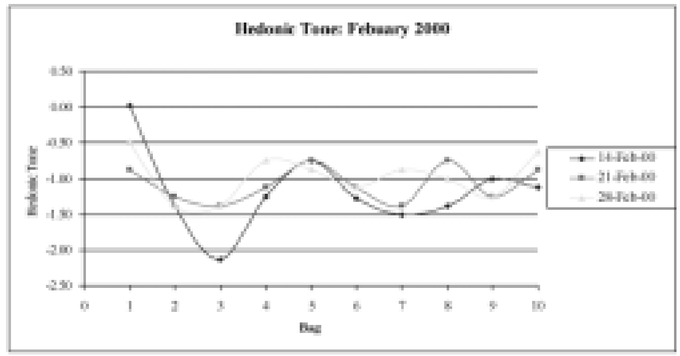
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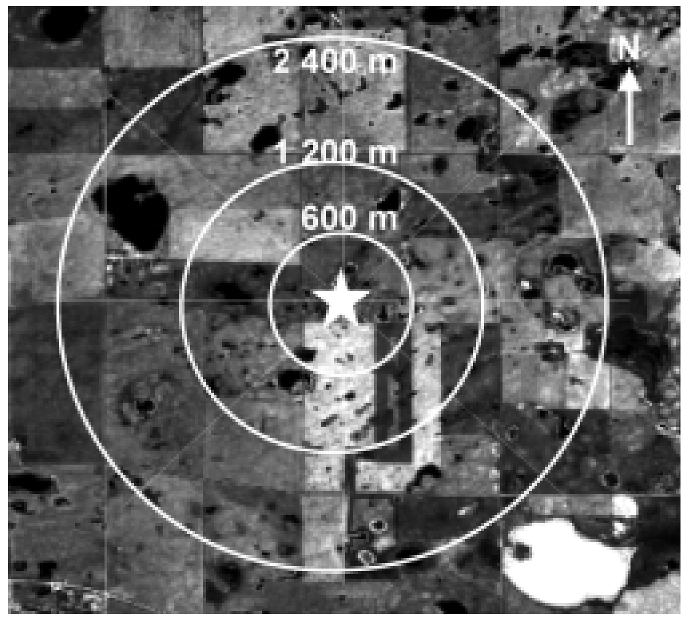
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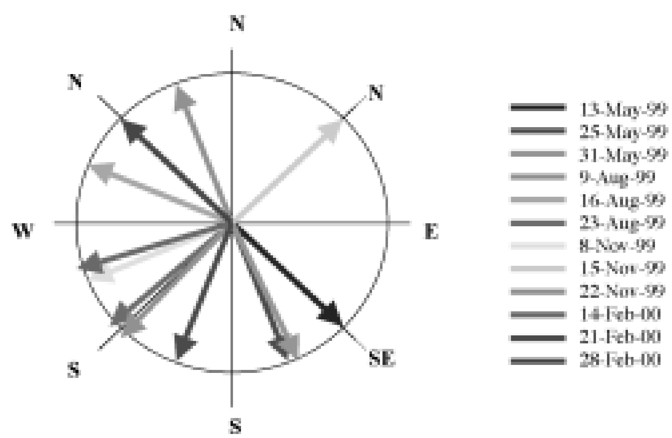
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EVALUATION AND DEMONSTRATION OF DEADS COMPOSTING AS AN OPTION FOR DEAD ANIMAL MANAGEMENT IN SASKATCHEWAN

T. A. Fonstad [1], J. Leonard2, D. E. Meier [1] and L. J. Ingram [1]

Introduction

The expansion of the hog industry in Saskatchewan has created the need for new advancements to develop an economically and environmentally sustainable industry. Dead animal management is just one area of the livestock industry that producers need to be mindful of.

Composting has the potential to be an environmentally and economically sustainable option for on-farm disposal of dead stock.

Objectives

The purpose of this investigation is to determine whether composting mortalities is a viable option for dead animal disposal for hog producers in Saskatchewan.

Experimental Procedure

A test compost pile (deads pile) was constructed using a straw/manure mix provided by the animal shelters of the operation. Mortalities were added to this mix in increments of 150 kg. An additional compost pile composed of straw/manure mix only was constructed as the control. Temperature and oxygen measurements were taken weekly to track microbial activity.

In addition, volume reduction and moisture conditions were monitored to evaluate the overall progress and efficiency of the composting process. At the end of the study period, the deads pile was screened to quantify any objectionable material within the compost pile to evaluate the effectiveness of using compost as a method of deads disposal.

Measuring oxygen level and temperature of a compost pile.

Results

Temperature and oxygen were used to determine when the compost pile required aeration. Observations of the deads composting pile during pile aeration showed that the carcasses were broken down successfully. This was verified when the deads compost pile was screened revealing that, on a dry mass basis, only 0.04% of the compost pile was deemed to be recognizable remains.

Moisture conditions remained within the ideal range for composting throughout the compost period and a significant volume reduction was noticed. The volume of the manure/straw pile reduced approximately 40 – 50%.

Composting is an effective way to get rid of deads.

Conclusions

Composting mortalities as a method of dead animal management on a commercial hog operation in Saskatchewan has shown to be quite successful. Results show that carcasses can be effectively disposed of with minimal effort from the producer. Information from this study will help to establish guidelines and protocols for producers in Saskatchewan to follow for establishment of a composting program on their operation.

Acknowledgements

The authors would like to thank Cover-All Building Systems, Henry Quiring and staff at Marvel Acres Hog Farm, Saskatchewan Pork Central and Saskatchewan Agricultural Development Fund for their contributions.

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EARTHEN MANURE STORAGE MONITORING: PSC ELSTOW RESEARCH FARM INC.

T.A. Fonstad [1], C. P. Maule [1], L.Ingram [1], D.Meier [1], S. Perih [1] and H. Filson, S. Gibbard [2]

Introduction

Rapid growth in the Saskatchewan hog industry has caused an increase in environmental awareness among the public. This has led to more stringent environmental standards being imposed on the construction of earthen manure storages. Most storages are now required to have a minimum 600-mm thick liner made of recompacted clay soils. More extreme cases require a geotextile liner. These recommendations have resulted in a significant improvement over the unlined and uncompacted storages constructed in the past. Unfortunately, these improved liners have done little to alleviate public concern in some areas. In answer to this concern, a program was initiated to monitor solute migration through the liners of different hog manure storages throughout Saskatchewan.

Objectives

The main objectives of this project are to:

- Determine changes in groundwater chemistry with depth over time,
- Determine effectiveness of clay liners and clarify liner requirements, and,
- Determine safe separation distance between EMSs and any potential aquifers.

The new Prairie Swine Center Research Facility at Elstow has been included in this study as one of the new sites.

The System

The system installed allows in situ measurement of hydraulic head, temperature and oxidation/reduction potential as well as the ability to retrieve water samples at 16 locations within and below the liner of each cell and 8 locations adjacent to each cell (see Figure 1). Figure 2 shows the instrument bundle, containing two lines of suction tubing, a pneumatic piezometer, a thermocouple, and a redox tip. This bundle is placed in the 16 locations underneath the EMS. When suction is applied to the sample tubing, a water sample can be retrieved for nutrient analysis. The pneumatic piezometer gives the water head at the depth. The thermocouple allows temperature to be recorded, and the reduction-oxidation probe gives the redox conditions of the groundwater, which can help to determine the groundwater chemistry.

To date, this system has been installed in three newly constructed sites and two established sites.

Acknowledgements

We would like to acknowledge Saskatchewan Agricultural Development Fund and Prairie Farm Rehabilitation Administration for funding and in kind contributions.

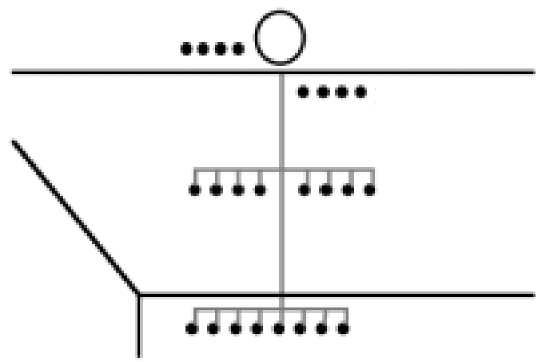

Figure 1 - Schematic of hole locations

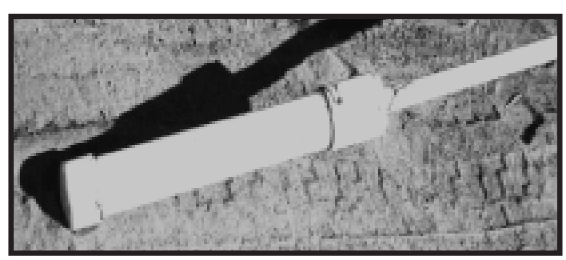

Figure 2 - Instrument Bundle

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PARTICLE SIZE REDUCTION AND ENZYME SUPPLEMENTATION REDUCE NUTRIENT EXCRETION

Matt A. Oryschak [1], Ruurd T. Zijlstra, P. Howard Simmins [2]

Summary

Diets based on barley and peas ground to three different particle sizes and with one of four enzyme treatments were fed to growing pigs. Reducing particle size below 700 mm was most effective in reducing nitrogen excretion while the addition of phytase was most effective in reducing phosphorus excretion.

Introduction

Nutrient management in hog production might impact the long-term sustainability of the industry. One approach is to minimize the amount of nutrients, primarily nitrogen (N) and phosphorus (P), being produced by each operation. Two strategies by which this may be accomplished are particle size reduction and enzyme supplementation.

Experimental Procedures

Three particle sizes (400, fine; 700, medium; and 850 mm, coarse) were compared within four enzyme treatments (control, carbohydrase (ß-glucanase and xylanase), phytase, and phytase with carbohydrase) for a total of 12 experimental diets. Diets were based on barley (70%) and field peas (25%) and were fed in wet mash form.

Results and Discussion

Total N excretion was reduced by 6.8% for fine compared to medium particle size ($P < 0.05$). The addition of phytase reduced total N excretion by 5.5% compared to the control. Fecal and total P excretion were reduced 35% by phytase and 22% by phytase and carbohydrase supplementation respectively, compared to the control ($P < 0.05$). Addition of carbohydrase enzymes did not affect either N or P excretion.

Implications

Reducing particle size below 700 mm proved effective in increasing the digestibility of several nutrients in the diet, and in altering N excretion patterns. Phytase proved very effective in improving the retention of P from the diet, while the addition of carbohydrase showed little benefit in reducing N or P excretion.

Acknowledgements

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Reduced feed particle size and phytase supplement reduces nutrient excretion.

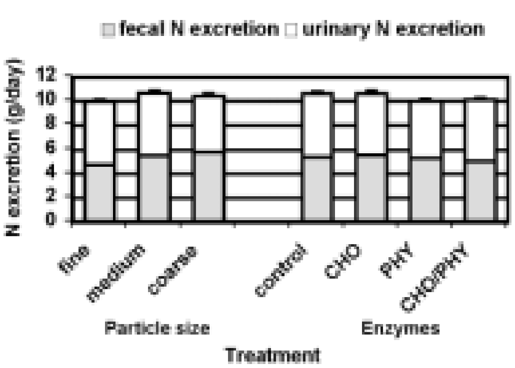

Figure 1. Total nitrogen excretion

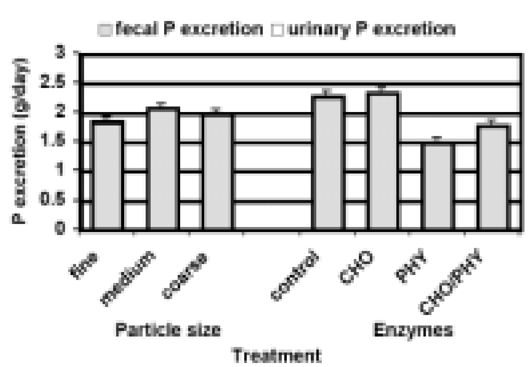

Figure 2. Total phosphorus excretion

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EFFECT OF DIETARY PROTEIN AND FIBER ON NITROGEN EXCRETION

Symeon Zervas [1], and Ruurd T. Zijlstra

Protein reduction in diets reduces nitrogen excretion.

Summary

Nitrogen excretion is of concern because of its potential impact on the environment inside and outside the barn. Reduction of dietary protein content decreased overall nitrogen excretion, but especially in the urine. Urinary nitrogen excretion could be predicted from plasma urea nitrogen (PUN) concentration.

Introduction

The intensification of pig production has raised environmental concerns. Urinary nitrogen is emitted easily as ammonia while fecal nitrogen is less volatile because it is bound within proteins. Reduction of dietary protein is a direct way to reduce nitrogen excretion and ammonia emission. Nitrogen excretion can be shifted from urea in urine to bacterial protein in feces with dietary fermentable carbohydrates. In the present study, effects of three levels of protein and two levels of fiber on nitrogen excretion patterns were investigated.

Experimental Procedures

Diets (wheat, barley, soybean meal; oat-hulls as a fiber source) were formulated to 3250 kcal DE/kg and 2.18 g Dlys/Mcal, supplemented with synthetic amino acids. Feces, urine and blood samples were collected. Daily feeding rates were adjusted to three times maintenance.

Results and Discussion

Fecal nitrogen was decreased 10 and 23% respectively for low compared to medium and the high protein diets (Figure 1). Urinary nitrogen was reduced 35 and 48% respectively for low compared to medium and high protein diets. Excretion of nitrogen was reduced 26 and 40% respectively for low protein compared to medium and high CP diets. Dietary fiber did not affect urinary, fecal and total N excretion. Oat hulls might not be a good source of fermentable carbohydrates for grower pigs. Retention of N was reduced 9 and 18% respectively for low compared to medium and high CP diets. Nitrogen retention was six% higher for the high compared to low fiber diets. Regression analysis showed that PUN could predict urinary N excretion (Figure 2).

Implications

Reduction of dietary protein content is effective in reducing nitrogen excretion, especially urinary nitrogen. Oat hulls did not affect nitrogen excretion, probably because of the low content of fermentable carbohydrates. Further research is required to maintain protein deposition. Models to predict urinary N excretion might be helpful to access N status on farms.

Acknowledgements

Strategic program funding provided by SaskPork, Alberta Pork, Manitoba Pork, and Saskatchewan Agriculture and Food Development Fund. Direct funding for this project was provided by AARI and NSERC.

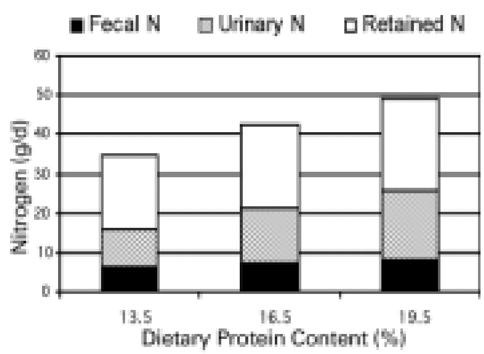

Figure 1. Effects of dietary protein level on N excretion patterns.

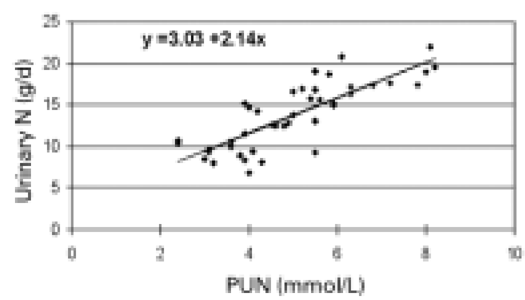

Figure 2. Relationship of plasma urea nitrogen (PUN) to urinary N excretion at four hours after feeding (R^2 = 0.65).

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INFLUENCE OF HOG MANURE APPLICATION ON WATER QUALITY AND SOIL PRODUCTIVITY

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Introduction

Hog manure is known to be a valuable source of nutrients but there is little documented knowledge about the environmental impacts of organic fertilizers on ecosystems of semi-arid to sub-humid ecosystems.

This study will directly address manure management on croplands and as well, the environmental and health concerns with the use of hog manure as a fertilizer.

Manure injection into stubble.
Hog manure is valuable fertilizer, but we need to know more about environmental impact.

Objectives

Within the context of hog manure as a fertilizer for dryland crops, the objectives of this project are to:

- Measure the presence and potential pollutants in soils, runoff waters and shallow groundwater,
- Provide recommendations to prevent the accumulation of environmental or health related pollutants,
- Provide recommendations as to application rates based on soil productivity on a landscape basis and
- Establish a protocol for long term monitoring.

Experimental Procedure

This study takes place over a period of six years (1998 to 2004) at two locations: near Perdue, SK at Heartland Bear Hills Pork Producers and one near Elstow, SK at the PSC Elstow Research Farm Inc.

Field measurements are taken to determine soil and water quality at the application sites.

Parameters measured include dissolved solids, total nitrogen, total phosphorous, carbon, heavy metals and coliform bacteria.

Runoff quality is evaluated by snowmelt runoff, which is collected by way of weirs and by spot runoff simulation experiments. Standing water is also evaluated one to three times a year.

Shallow soil samples are taken in the spring and fall of each year to monitor available nutrients and to help predict future application rates. Soil moisture to three metres is measured three times a year in designated field locations.

Detailed soil and groundwater analysis was performed in 1998 and will be repeated at the end of the study at each baseline sample location.

Ongoing work at Perdue and Elstow looks at land and water before and after manure application.

Results

At the Perdue site, baseline soil and water data was collected during the period between fall 1998 and fall 1999 and the first manure application took place in October 1999. Post - application data collection has been taking place through 2000. Preliminary results are expected to be evaluated beginning spring of 2001.

Baseline data has been collected at the Elstow site during 1999 and 2000. The first manure application at this site is expected to be fall 2001.

Acknowledgements

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CLOGGING AND FLOW REDUCTION IN SOIL MATERIALS BY PONDED HOG MANURE

T.A. Fonstad [1] and C.P. Maulé [1]

Liquid manure can clog soil pores, but the effect is easily disturbed and can't substitute for proper earthen storage design.

Introduction

Earthen manure storages offer an economically viable means of storing manure as compared to concrete or steel tanks. Ground water contamination is a concern if improper soil materials are used or if improper construction techniques are used. Previous research done in Quebec has shown that liquid manure can cause clogging and a great reduction in seepage rates. We conducted a laboratory and field study to confirm these findings for Saskatchewan soil materials and conditions. Within this summary we present some of our laboratory findings.

Experimental Procedure

We packed three replicates of seven different sub soil materials into a total of 21 clear plexiglass columns. The columns were first ponded and measured with water for 30 days, then with manure for 630 days, then with a 'chemical' manure that had a similar ionic composition as hog manure but without the organics. The columns were stored in a room at 6°C, so as to minimize biological effects. Over the period of 630 days two sets of replicates were taken apart for chemical and physical anlaysis. The soils were 20 cm thick with 60 cm of liquid ponded on them.

Findings

Almost immediately after the soils were ponded with manure, flow was reduced by 100 to 1000 times with little effect by texture (see graph). A one mm black layer was observed at the manure/soil interface (photo). This layer grew (into the soil) to about 8 mm thick over the 630 days. The flow remained at these low values during the 630 days except twice when the cooling system had a 24 hr failure and the flow rates increased by five to 10 fold. After 630 days the manure and the black layer were carefully removed. A chemical solution similar to the manure, but having no solids, was then ponded on the soil columns. The flow rates increased to almost exactly what they were as measured with water, before the manure had been put on (see graph).

Implications

Liquid hog manure can effectively clog soil pores, however the clogging can be easily disturbed and appears to be a surface effect. Warmer temperatures and biological activity might also disrupt this clogging effect. The presence of clogging should not be used as a substitute for properly chosen and well engineered earthen materials in manure storages.

Acknowledgements

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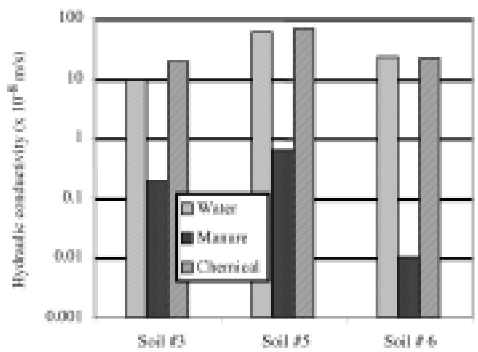
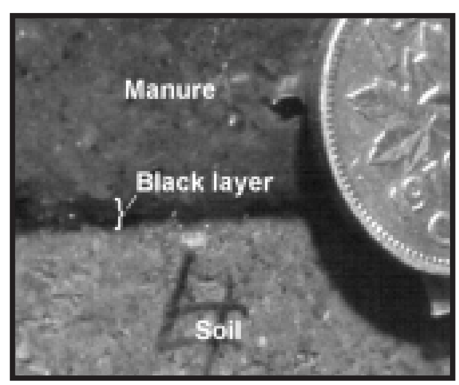


Figure 1. Effect of soil and ponded solution on hydraulic conductivity



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MASK USE IN SWINE BARNS REDUCES HEALTH EFFECTS

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Background

Swine producers are exposed to dusts and gases when working in barns. Studies have shown that these workers are at increased risk of developing respiratory symptoms, decreases in lung function levels and increases in airway reactions. Engineering controls are in development in an attempt to reduce the dust and gas levels in this work environment. One method for reducing worker exposure to dusts is by having workers wear a disposable respirator (mask) during barn work activities.

The objective of the study was to evaluate health effects related to wearing a disposable mask in a swine confinement unit.

Without a mask, lung function is impaired by over 8%.

Study Design

Twenty-one subjects between the ages of 18 and 35 years old were recruited to participate in the study. These subjects were male, nonsmokers, with no asthma or allergies and had no previous exposure to a swine barn environment.

The study was conducted to assess subjects' health reactions after a four-hour exposure in a grower/finisher room while wearing a mask and not wearing a mask. Subject responses were measured at three separate occasions: after four hours in an office setting; after a four hour exposure wearing a disposable mask in a grower finisher room; and after a four hour exposure in a grower/finisher room without a mask.

The grower/finisher room measured 14.3 m X 11.0 m X 3.0 m. The pen floor was partially slatted (30% of the pen area). A total of 132 pigs were housed in the room with 95 kg being the average mass of the animals at the completion of the study. The management of the room and the production methods conformed to those commonly used in the swine industry in Saskatchewan. Over the course of the 2.5 week study, the alleyway of the room was not swept or cleaned.

Subjects' health response to the environment was measured by lung function tests, methacholine challenge tests, nasal lavage, blood tests and symptom scores. The personal exposure level to dusts and endotoxin were measured over the exposure period. Area samples for gases, temperature and humidity were also measured.

Dust masks help, but aren't a long term solution.

Results

Self reported symptom scores of subjects are shown in Figure 1 and indicate that cough, phlegm and chest tightness were significantly greater when a mask was not worn compared to when a mask was worn. Lung function results indicate that during the office exposure day and the exposure day when a mask was worn, there was slight improvement in lung function over the exposure periods (Figure 2). On the exposure day when no mask was worn, an average reduction in lung function of 8.12% was observed over the four-hour exposure period (Figure 2). These same trends were observed in other measures of health status of these subjects over the exposure period. Dust, gas and endotoxin results indicate that there was very little variation in the environmental levels over the study period.

Conclusion

These results indicate that the use of a well-fit disposable mask over a four-hour exposure period by persons previously unexposed to a swine barn environment reduces respiratory symptoms and reductions in lung function.

While personal protection is useful to assist workers in short-term high-dose exposures, we believe that long-term prevention of dysfunction requires the development of production and engineering control technologies that allow workers to function within a healthful environment.

Figure 1: Comparison of respiratory symptoms while wearing a mask and not wearing a mask.

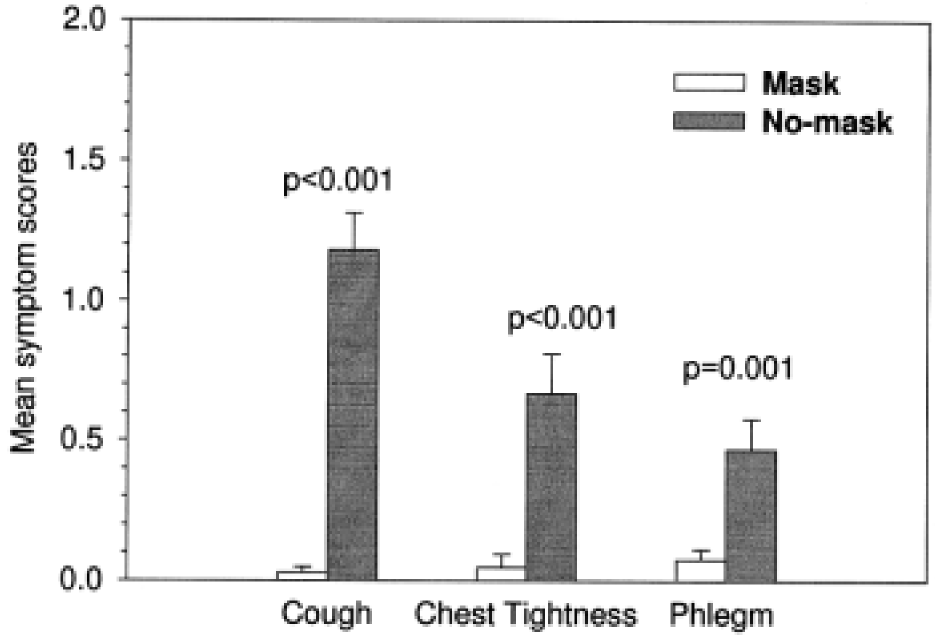
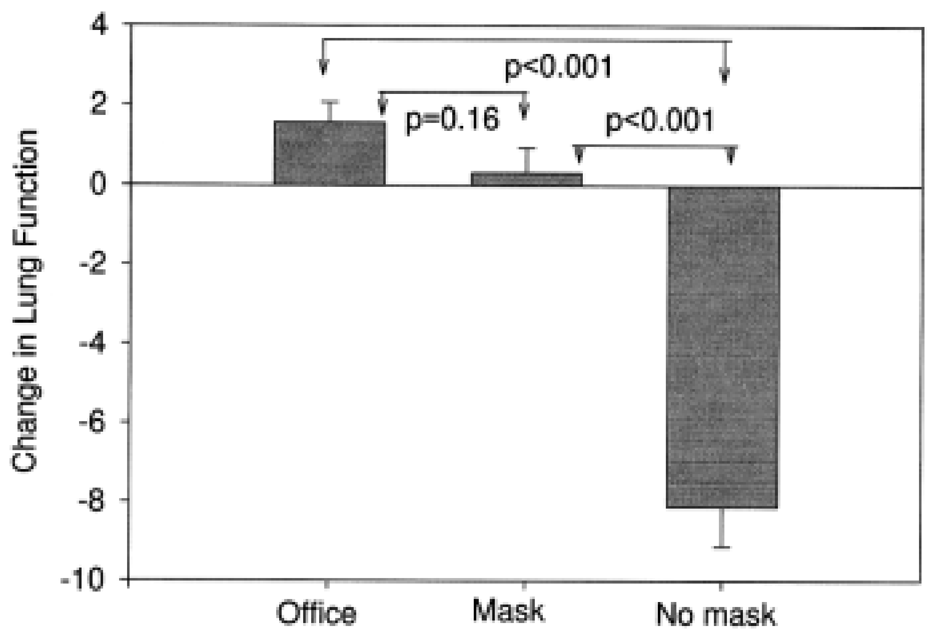


Figure 2: Comparison of changes in lung function for the three exposures.



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