PRAIRIE SWINE CENTRE INC.

The Prairie Swine Centre is pleased to present our 1998 Annual Research Report

HIGHLIGHTS

- **Predicting the nutritional value of grains is more accurate based on chemical characteristics than based on density (bushel weight). (p.26)**

- **Reformulating diets using actual DE values results in equal performance among 11 field pea varieties studied. (p.28)**

- **Barley DE can be accurately predicted by using Near Infra Red Spectroscopy (NIRS). (p.30)**

- **Beneficial effects of enzyme supplementation to wheat-canola meal diets in weaned pigs are due to increased feed intake. (p.33)**

- **Sorting pigs by weight into uniform pens at the beginning of the grow-finish phase is not advantageous. (p.37)**

- **Evaluation procedure established by testing humidity sensors under barn conditions. (p.40)**

- **Swine barn odour is a combination of more than 160 compounds. Methods for testing, evaluation and controlling odours is discussed. (p.47)**

"The mission of Prairie Swine Centre Inc. is to provide a centre of excellence in research, technology transfer and education, all directed at the enhancement of efficient, sustainable pork production in Canada."

CONTENTS

THE PRAIRIE SWINE CENTRE

Preface

The research, technology transfer and education activities at Prairie Swine Centre Inc. focus on improving efficiency and sustainability of commercial pork production. Our main research activities are in the areas of nutrition, behaviour and engineering. The Centre seeks to address the needs of the commercial pork industry by providing a multi-disciplinary approach to research. This approach recognizes that pork production is a system. How well the "system" functions is dependent on the ability of farm management and production technicians to interpret and blend research results to address real farm challenges. This approach recognizes that changes in one area, for example nutrition, may have an impact on or be influenced by pen, or feeder design and certainly will be influenced by barn environmental conditions such as temperature.

The primary role of research is to provide answers, in this case the Centre is seeking answers to production questions. This "near-market" approach helps to ensure that new technologies or management improvements can be applied quickly and provide the broadest possible return to the industry which funds the research. The Centre must attract industry funding in order to survive. With this in mind, the Centre is constantly communicating with the industry to ensure that programs meet the needs of a changing industry. This communication process involves many activities that send information from the Centre, but just as critical, are the many meetings and industry events which the Centre participates in to allow direct access of pork producers to communicate their priorities to the Centre. A recent series of six meetings across western Canada was conducted to solicit research priorities in preparation for the development of an expanded research facility. Participants represented all aspects of the industry including primary producers, governments, suppliers, and other research institutions. The results of these meetings are detailed in this publication in the section Proposed Research Facility.

Focus for the coming year

Returning to profitability is the primary focus of every North American pork producer. Many of the recent results from the Centre can contribute to lowering costs and improving revenues, although these are always important results of our research program, ensuring pork producers are informed of these and other innovations is the primary focus. A recent mailing of the Survival Strategies Checklist to all western Canadian pork producers details opportunities for savings in all areas of the operation.

Pork production and its relationship to the environment plays an increasing role in daily pork production activities. Increased emphasis in this area at the Centre includes research on minimizing the impact of pork production on water resources, feeding systems to minimize environmental impact, pit additives, and further development of a web-based database of environmental research information.

Studies currently underway include:

- Impact of energy intake on protein and fat accretion in the growing pig
- Defining the amino acid requirements of grower-finisher pigs based on lean tissue gain and daily nutrient intake
- Use of exogenous enzymes to improve feeding value of canola meal
- Measurements to predict the swine Digestible Energy (DE) of barley
- Impact of variation in the nutritive value of field peas
- Defining the threonine requirements of the high producing lactating sow
- Optimizing the nutrition and management of the site segregated early wean pig
- Development of humidity sensors and heating/ventilation controllers for livestock buildings

Thank you for your support

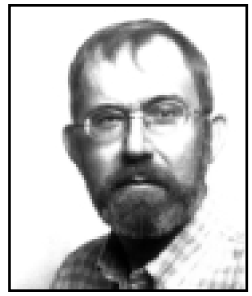
We would like to take this opportunity to thank everyone who has contributed their time talents and financial resources to ensuring progress has been made toward fulfilling the Centre's commitment to the pork industry. Our thanks to the pork producers, government agencies, consultants, veterinarians, suppliers of products and services, and public research institutions.

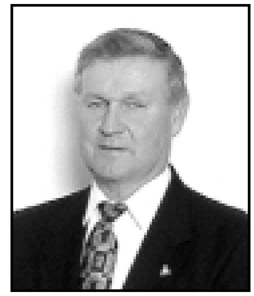
BOARD OF DIRECTORS


Jim Smith

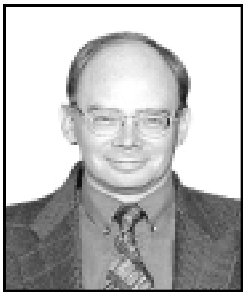

Wayne Vermette


Florian Possberg


Ron Rempel

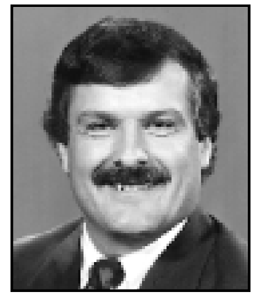

Cam Henry


Brian Harvey


Terry Scott


Mac Sheppard


John Stewart


John Patience

Board of Directors

The Centre's Board of Directors has 10 members as of June 30, 1998. They represent the diverse interests of the western Canadian swine industry, including:

Mr. Jim Smith, Chairman, Prairie Swine Centre Board of Directors, Alberta pork producer,

Mr. Wayne Vermette, Saskatchewan pork producer

Mr. Florian Possberg, Saskatchewan pork producer

Mr. Ron Rempel, Manitoba pork producer

Mr. Cam Henry, Manitoba grain producer
Dr. Brian Harvey, Agricultural Research Coordinator, University of Saskatchewan

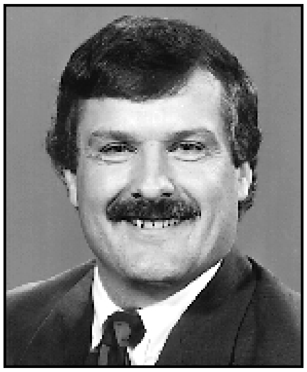
Mr. Terry Scott, Deputy Minster of Agriculture
Saskatchewan Agriculture and Food

Mr. Mac Sheppard, controller (recently retired), University of Saskatchewan

Dr. John Stewart, Dean of Agriculture, University of Saskatchewan

Dr. John Patience, President Prairie Swine Centre,

STAFF AND ASSOCIATES



John F. Patience, Ph.D.
President & Chief Executive Officer

Phone (306) 477-7449
FAX: (306) 955-2510
Email:
patience@sask.usask.ca

Employment History

1975 - 1978	Swine Specialist, Saskatchewan Department of Agriculture, Regina, SK
1978 - 1982	Nutritionist, Feed Dept., Federated Co-operatives Ltd., Saskatoon, SK
1985 - 1987	Visiting Fellow, Animal Research Centre, AAFC, Ottawa, ON
1987 -	Adjunct Professor, University of Saskatchewan, Saskatoon, SK
1987 - 1989	Research Scientist, University of Saskatchewan, Saskatoon, SK
1989 - 1991	Associated Professor, University of Saskatchewan, Saskatoon, SK
1991 -	President and Chief Executive Officer, Prairie Swine Centre Inc., Saskatoon, SK

Current Research Program

- Definition of the amino acid requirements of swine using factorial approaches
- Evaluating the impact of water quality on animal health and productivity
- Optimizing the feeding and management of the early weaned (SEW) piglet
- Improved evaluation of the nutritive contribution of feed ingredients

Professional Associations

- Member, Canadian Society of Animal Science (President, 1993-94)
- Member, American Society of Animal Science
- Member, American Society for Nutritional Sciences
- Sigma Xi, The Scientific Society
- Canadian Society for Nutritional Sciences

Harold W. Gonyou, Ph.D
Research Scientist - Ethology

Phone (306) 477-7452
FAX: (306) 955-2510
Email:
gonyou@sask.usask.ca

Employment History

1980	Research Associate, University of Guelph, Guelph, ON
1980 - 1992	Professor, Dept. of Animal Science, University of Illinois, Urbana-champaign, IL
1988 - 1989	Visiting Professor, Department of Animal Science, Egerton University, Kenya
1992 -	Adjunct Professor, University of Saskatchewan, Saskatoon, SK
1992 -	Research Scientist - Ethology, Prairie Swine Centre Inc., Saskatoon, SK

Current Research Program

- Determining the impact of feeder orientation within the pen on behaviour and dunging patterns
- Evaluation of modern commercial feeders for the growing-finishing pig
- The modelling of space requirements for growing-finishing pigs
- Impact of group size on behaviour and productivity in growout

Professional Associations

- Member, Canadian Society of Animal Science
- Member, American Society of Animal Science
- Member, Animal Behaviour Society
- Member, International Society for Applied Ethology (President, 1992-93)

Stéphane P. Lemay, Ph.D.
Research Scientist - Engineering

Phone (306) 477-7451
FAX: (306) 955-2510
Email:
lemay@sask.usask.ca

Employment History

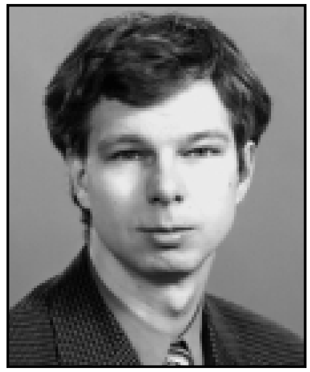
1996 - 1996	Research Assistant, Agriculture & AgriFood Canada, StË-Foy, QC
1996 -	Research Scientist - Engineering, Prairie Swine Centre Inc., Saskatoon, SK
1997 -	Adjunct Professor, University of Saskatchewan, Saskatoon, SK

Current Research Program

- Defining environmental management strategies, in growout phase, to maximize productivity and profitability
- Simulation of different humidity control strategies for swine buildings
- Development of humidity sensors and heating and ventilation controllers for livestock buildings
- Improved ventilation control strategies and methodologies
- Evaluation of products (eg. pit additives) and practices(eg. oil sprinkling) to enhance air quality in the barn

Professional Associations

- Member, Quebec Order of Engineers
- Member, Canadian Society of Agricultural Engineers
- Member, American society of Agricultural Engineers



Ruurd T. Zijlstra, Ph.D.
Research Scientist - Nutrition

Phone (306) 477-7450
FAX: (306) 955-2510
Email:
ruurd@sask.usask.ca

Employment History

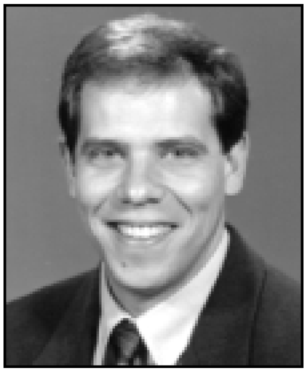
1998 -	Research Scientist - Nutrition, Prairie Swine Centre Inc., Saskatoon, SK
1998 -	Adjunct Professor, University of Saskatchewan, Saskatoon, SK
1996 - 1998	Research Associate - Nutrition, Prairie Swine Centre Inc., Saskatoon, SK

Current Research Program

- Evaluation of nutritional value of Western Canadian feed ingredients
- Nutritional strategies to reduce environmental impact of the swine industry
- Physiological and immunological responses of the small intestine to nutritional factors and pathogens afflicting young pigs

Professional Associations

- Member, American Society of Animal Science
- Associate Member, American Society of Nutritional Sciences



Eduardo Beltranena, Ph.D.
Manager - External Research Services

Phone (306) 477-7455
FAX: (306) 955-2510
Email:
beltranena@sask.usask.ca

Employment History

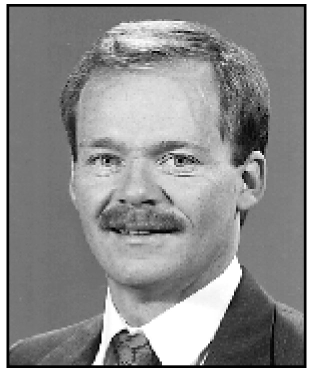
1982 - 1986	Manager -Operations, Granja La Esperanza, Cadereyta, NL, Mexico
ALDABI -	Consultores en Nutricion Animal, Monterrey, Mexico
	Owner/Operator, Cryogenico S.A. de C.V., Monterrey, Mexico
1991 - 1994	Nutritionist, Calmar Feed Mill Ltd., Calmar, AB
1994 -	Manager - External Research Services, Prairie Swine Centre Inc., Saskatoon, SK

Current Activities

- Management of Contract Research Program
- Establishment of GLP and GMP standards for conduct of research
- Management of information systems

Professional Associations

- Member, American Society of Animal Science
- Member, American Association of Swine Practitioners
- Member, US Society of Quality Assurance



Mr. Lee Whittington, M.B.A.
Manager - Information Services

Phone (306) 477-7447
FAX: (306) 955-2510
Email:
whittington@sask.usask.ca

Employment History

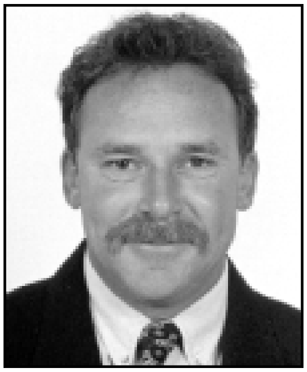
1979 - 1985	Sales/Sales Supervisor, Shur-Gain Feeds, St. Marys, ON
1985 - 1992	Nutritionist/Swine Products Marketing Shur-Gain Feeds St. Marys, ON
1992 -	Manager -Information Services, Prairie Swine Centre Inc., Saskatoon, SK

Significant Activities in Technology Transfer

- Management of Technology Transfer Program
- Managing editor of 'Centred on Swine'
- Managing editor of the Annual Research report
- Pork producer consultation via information line (477-PIGS)
- Development and maintenance of environmental Issues Database
- Delivery of 1999 Satellite Conference

Professional Associations

- Member, VIDO Swine Technical Group
- Member, Canada-Saskatchewan Agri-Food Innovation Fund Strategic Committee
- Member, Canadian Agri-Marketing Association
- Member, SaskPork Research Committee



Mr. Brian Andries, B.Sc.
Manager - Operations

Phone (306) 477-7448
FAX: (306) 477-7453
Email:
andries@sask.usask.ca

Employment History

1979 - 1992 Prairie Swine Centre , University of Saskatchewan, Saskatoon, SK
1992 - Manager - Operations, Prairie Swine Centre Inc., Saskatoon, SK

Current Activities

- Management of all animal resources and barn facilities

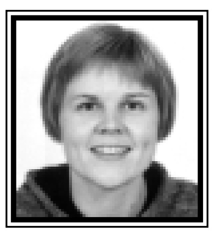
Post Doctoral

Dr. Mark Lorschy
Citizenship - Australia
Degree - PhD Nutrition
Last appointment - University of Minnesota
Area of research - Amino acid/energy interaction in growing-finishing pigs

Dr. Huiging Guo
Citizenship - Chinese
Degree - PhD Engineering
Last appointment - Post Doctoral Researcher and Associate Professor, Dept. of Horticulture, Shenyang Agricultural University, China
Area of Research - humidity control and ventilation strategies

Graduate Students

Dana Ball
Degree sought:
M.Sc. in Nutrition



Moira Harris
Degree earned:
M.Sc. in Ethology
Degree sought:
Ph.D. in Ethology

Matthew Oryshak
M.Sc. in Nutrition

Stephanie Schmolke
Degree sought:
M.Sc. in Ethology

Ryan Stinson
Degree sought:
M.Sc. in Engineering

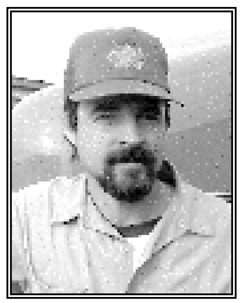
Maria Lambert
Degree sought:
M.Sc. in Engineering

Training Programs

Ms. Mary Petersen, B.Ed.
Coordinator of Training Programs
Phone: (306) 477-1674
Current Activities: Coordinates the development of the Management Training Program.

Administration Staff
left to right:
Christine Wakabayashi (Financial Manager),
Audrey McFarlane (Secretary).

Proprietary Research Group
left to right: Alison Orr, Research Technician,
Dr. Eduardo Beltranena, Manager-External Research,
Raelene Petracek, Research Technician.



Kelly Sauder,
Farm worker

Production and Technical Staff
Standing left to right:
Heidi Moorhead, Alison Orr, Tanya Sereda, Kelly Sauder, Doug Gillis,
Sydney Chicoine, Brent Hill, Marc Damant, Garth McDonald
Sitting left to right:
Brian Andries, Karen Wurtz, Rob Fengler, Troy Donauer, Raelene Petracek, John Meier

FINANCIAL SUPPORT

Prairie Swine Centre Inc. wants to acknowledge the many individuals and agencies that supported the research and technology transfer programs this past year. This support is essential to the ongoing developments that will keep Canadian pork producers at the forefront of applied technology. In addition to industry and government funding, the University of Saskatchewan contracts the facilities and services of PSCI for research and teaching. This ongoing agreement provides income for the Centre in return for the use of modern production and research facilities.

The following organizations have provided funding or donations in kind to support public research at the Centre for the 1997/1998 year. Their support is greatly appreciated.

Pork Producers of Saskatchewan
SASK Pork(formerly SPI Marketing Group)
Swine Improvement Services Co-op

Pork Producers of Alberta
Alberta Pork Producers Development Corporation

Pork Producers of Manitoba
Manitoba Pork Est.
Ontario Pork Producers Marketing Board
Pork Producers of Ontario

Government
Alberta Agricultural Research Institute
Agricultural Development Fund
Canada-Saskatchewan Green Plan Agreement
Natural Sciences and Engineering Research Council of Canada (NSERC)
Saskatchewan Agriculture and Food

Institutions
Inspiraplex
United States Department of Agriculture (USDA)
University of Maryland
University of Saskatchewan

Industry Donations
ADM Bioproducts
Alberta Barley Commission
Animal Welfare Foundation
B.C. Hog Marketing Commission
Canadian Farm Animal Care Trust
Canadian Feed Industry Association
Canola Council of Canada
Central Water Conditioning
Degussa Corporation
Feed Flavors Incorporated
Feed Rite Ltd.
Pig Improvement (Canada) Ltd.
Ralston - Purina Canada Inc.
TDK Corporation of America
Western Grains Research Foundation

Many corporations provide funding in support of technology transfer programs conducted by the Centre. We wish to acknowledge their contribution for assisting the Centre in encouraging the adoption of new technologies by Canadian Pork Producers.

Prime Cut Sponsors
Agricultural Institute of Management,in Saskatchewan, Inc.
American Protein Corporation
Bank of Montreal
Canadian Bio-Systems Inc.
FAROEX
J.Webster Laboratories Inc.
Pig Improvement (Canada) Inc.

Premium Cut Sponsors
Better Feeders Ltd.
Boehringer Ingelheim Canada Ltd.
Co-op Feeds
DEL-AIR Systems
Diamond V Mills
Elite Swine Inc.
Enviro-Test Laboratories
Finnfeeds International Inc.
Heartland Livestock
Intercontinental Packers 1997 Ltd.
National Pig Development (Canada) Co. Ltd.
Pharmacia & Upjohn Animal Health
Prairie Pride Enterprises
Puratone Corporation
Saskatchewan Pork Producers
SaskTel
Scotiabank
Sheridan and Heuser Swine Health Services
Unipork Genetics

Quality Cut Sponsors
Alberta Swine Genetics Corporation
Betker Livestock Equipment
Canola Council of Canada
Calmar Feed Mill Ltd.
Dalland Value Added Pork Inc.
Feed-Rite
Fletchers Fine Foods Ltd.
Grand Laboratories inc.
Kenpal Farm Products Inc.
Pfizer Animal Health
Phason, Division of Wintech Inc.
Pro-Ag Products Ltd.
Minitube Canada (Division of Minitube International)
Stirdon Systems

CHAIRMAN'S REPORT

Jim Smith
Chairman of the Board

CHAIRMAN'S REPORT - JIM SMITH

Mr. Jim Smith, Innisfail Alberta

This year, like all others that have preceded it, had its share of challenges, these were reflected in the many headlines: "Threat of Swine Fever in Europe Expanding", "Lowest Prices for Pork in 30 Years", "United Kingdom Bans Sow Stalls", "Growth Promoters Banned in Europe", and Farm Stress Levels Rising". As the industry seeks to position itself as the meat protein supplier of choice for the world's consumers, it is apparent that significant change lies ahead.

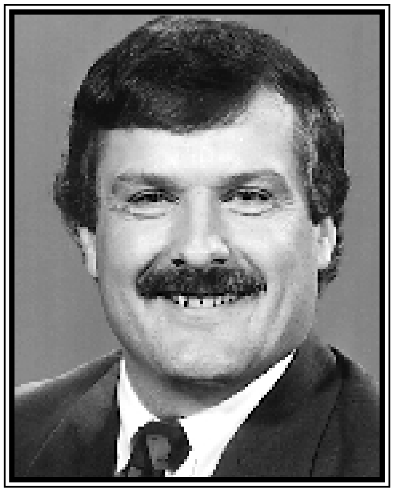
Locally, our industry structure has taken a bold step forward to identify those activities which are for the good of all players and place these important functions in the hands of pork producers, elected by their industry to represent the interests of all. Research is one of those universal interests which has always received significant attention and funding from pork producers. It has been my pleasure during the past year to serve as the chairman of the Board at Prairie Swine Centre Inc., and to participate in the development of practical solutions to swine production challenges.

During the past year the Centre has prepared action plans to proceed with a new barn. This facility will be commercial in design and have the flexibility to do research work that will complement the Centre's current capabilities. For example, the new facility will look at large group housing of sows, and finishing pigs, and manure management will become an increasingly important area of work. The process of establishing such a unit has begun with a series of six meetings across western Canada. These included pork producers, researchers, and various industry representatives. These meetings have clarified what the research needs are and how the new research program can be developed. The scientists at the Centre will be building specific research programs based on these discussion groups. This new facility will serve the needs of all pork producers in helping us to adjust to the changing climate, politically, socially and structurally in which we will reside five years from now.

Success can be measured in many ways. I measure success on the ability to plan and follow through. The Centre's five research objectives have contributed substantially to the financial benefit of pork producers already. In the beginning, Objective #1 sought to reduce the cost of production by $2 per pig. Today we can count on the work done to-date would exceed $12/pig in improved net income. Our challenge is to ensure we are taking advantage of this knowledge. As pork producers we have not only the right to use the information generated at the Centre but also the obligation to take ownership for ensuring our investment is paying dividends on each farm by utilizing the information to improve our own businesses.

It has been a stormy year for our industry but I am confident that the progress being made today will provide us with the resources required to not only survive but thrive as independent pork producers in an increasingly competitive environment.

PRESIDENT'S REPORT



Dr. John Patience
President

1998 was not a kind year to the Canadian pork industry. The collapse of the market resulted in extreme hardship to pork producers and caused everyone in the industry to rethink their future. In the face of this crisis, I was continually impressed by the management skills exhibited by many producers. For this reason, I found it very difficult to read newspaper articles and listen to radio announcers describing the problem as self-imposed and the result of poor management. Nothing could be further from the truth. There is a reason why the Canadian pork industry is a strong global competitor, and it has much more to do with management and initiative, and less to do with "natural advantage," than many people think.

Those management skills are being put to a severe test under the current market conditions. While no one can make money on $50 hogs, losses can be minimized, and the speed of recovery hastened, by keeping the cost of production as low as possible. The Prairie Swine Centre has dedicated much of its efforts over the past 5 years to seeking ways to reduce costs and maximize income. We continued this focus in 1998 and will do so in the future, as Canadian producers seek to maintain their competitive position in the global marketplace. However, the current crisis places even greater emphasis on technology transfer, as the need to communicate research results to pork producers as quickly as possible has never been more important. Pork production is a highly technical industry, and access to technology is key for all producers.

Like all pork producers, the Prairie Swine Centre must focus on the immediate problems of the industry, and assist in any way that we can, but also keep an eye to the future. We know that the current depressed market prices are temporary - although we don't know how temporary(!) - and it is important to be well positioned for the future when profitability returns to our industry. Most producers will come out of this current market cycle with large bills to repay; the lower one's cost of production, and the higher one's revenues, the faster this debt can be retired.

In addition, the issue of the environment has not disappeared, and animal welfare will undoubtedly receive more attention in the future. As a research organization, it is critical that we maintain an appropriate balance between the industry's needs of today with those of tomorrow. For this reason, we were delighted to receive the grant of $3 million from the Government of Saskatchewan towards the construction of a new 600 sow research facility. While it seems ironic to be building a new facility when markets are so depressed, the most experienced members of our industry will advise that the best time to be build a barn is when markets are at their worst; in this way, once farrowing starts and pigs start reaching market some 5 months later, they catch a rising rather than a falling price cycle. One of the demands of our Board of Directors was that the new facility would have no adverse effect on the financial position of the existing Prairie Swine Centre. Consequently, construction and operation of this new facility will take place in a carefully planned, financially-sound manner.

Perhaps more critically, however, research is an activity that must prevail independent of market cycles, so the new facility makes sense from a research perspective as well. The new barn will complement the Centre's existing facilities at Floral, Saskatchewan and allow our scientists to do more work and complete it more rapidly than is now the case. They can do more work on the environment, particularly in the area of manure handling and management, and in the area of animal welfare. And with the larger herd, nutrition studies that take 1 to 2 years at Floral will be completed in one-third to one-quarter the time. The Government of Saskatchewan also provided 3 years of research funding to ensure that the new facilities would be well used. The new research facility will be described in greater detail in a separate section of this Annual Report.

There were many firsts at the Centre in 1998. The new Management Training Initiative, arising from demands from the pork industry, provides a modular training program to allow existing pork producers and barn workers to develop new management skills. A total of 20 day and a half modules on everything from personnel management to planning to enhanced technical skills will be developed and delivered over about a two to three year period. It thus allows existing owner-operators, as well as barn workers, to obtain management training with minimal disruption of normal barn activity. Lee Whittington and Mary Peterson are leading this new initiative by the Centre. Collaborations with neighbouring provinces are being developed, since our industry's training needs are not restricted by provincial boundaries. Financial assistance for the development of the training modules has come from Saskatchewan Agriculture and Food, Alberta Agriculture Food and Rural Development and Alberta Pork.

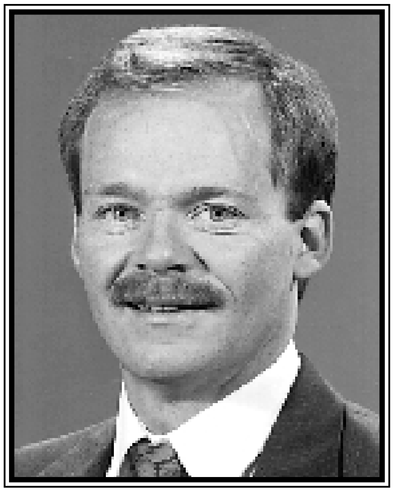
The Centre's website (http://adminsrv.usask.ca/psci) has been extensively redesigned by Eduardo Beltranena, as we see this becoming an increasingly useful vehicle for technology transfer. A new addition to the website is the Environmental Issues Resource Centre, a database of current information derived from the scientific literature on 13 different environmental issues. Producers, regulators and others with an interest on the subject are encouraged to visit our website and view this information. Development of the database was funded by the Ontario Pork Producers Marketing Board, who have kindly allowed it to be made generally available to the public. One goal of the database is to encourage informed discussion on environmental issues, thus keeping rhetoric to a minimum. Pork producers in Ontario, Manitoba, Saskatchewan and Alberta have agreed to provide funding to keep the database current; we are awaiting word on federal funding under HEMS to match the producer support.

Critical to the success of the Centre is the core program funding provided by the pork producers of Saskatchewan, Manitoba and Alberta and by Saskatchewan Agriculture and Food. It is upon this base that we can obtain additional funding, literally from around the world, to achieve our research and technology transfer objectives. For example, this year, the Centre was able to match, through a program administered by NSERC and Agriculture and AgriFood Canada, funds provided by Saskatchewan and Manitoba pork producers. Increasingly, public funding agencies are seeking demonstrable proof that applications they receive are supported by the industry. Producer funding is key in so many ways to our success. This year, we also welcomed new funding partners: the Western Grains Research Foundation and the Alberta Barley Commission.

I must recognize the efforts of our staff who are the backbone of our company. Their dedication allows the Centre to maintain a dynamic, internationally-recognized research program, a very successful production system and a vibrant technology transfer program.

Finally, the Board of Directors of the Centre play a critical role in defining our role and evaluating our progress. They are all very busy people in their own right, and we greatly appreciate their taking time to contribute to the success of the Centre.

INFORMATION MANAGER'S REPORT



Lee Whittington
Manager-Information Services

Partnerships Make Technology Transfer Happen

Pork producers in Saskatchewan, Manitoba and Alberta are our focus. Research is only relevant if it is relevant and useful to you, in your circumstances and under your constraints. As a result of this uniqueness of each farm we realize that not all of the research conducted at the Centre applies equally to every pork producer. Although size is often cited as a significant criteria in determining the usage of new knowledge, there are several other, much more significant factors which influence the decisions of farm owners and managers to adopt new technology. These include awareness of new developments, current priorities, current financial considerations, available labour, barn design, and perception of risk vs reward for making a change. For technology transfer to become 'technology adoption' we must provide to pork producers the information when they want it, how they want it and with sufficient clarity that financial and strategic farm decisions can be made with it. Thus technology transfer tries to combine science with some marketing and innovation to find the best means to deliver the facts.

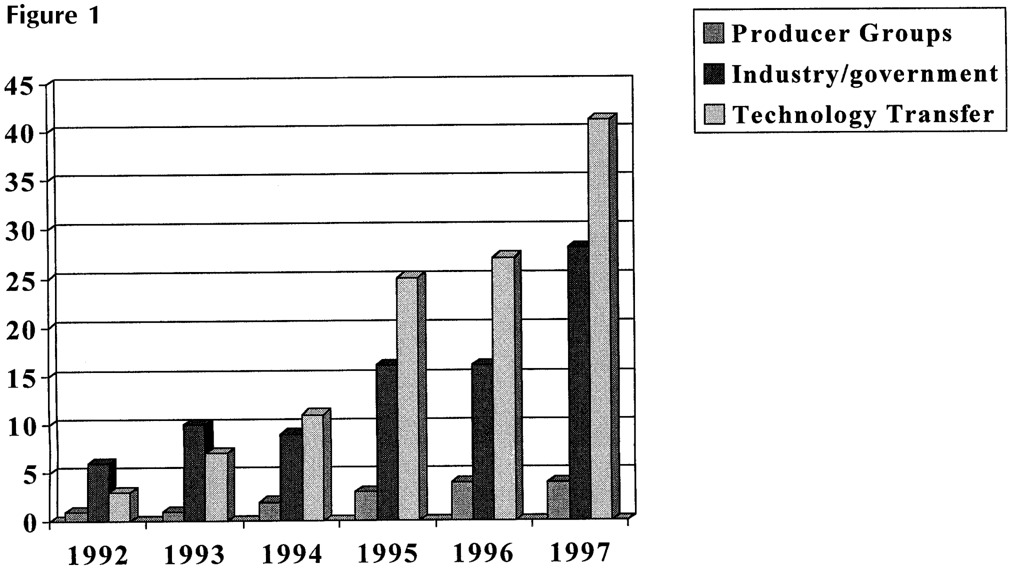
Reviewing the year's activities points out the number of individuals inside the Centre and within the larger industry that assist in 'making it happen'. Although it is my personal mandate to provide an active and visible technology transfer program, this effort is only made possible through the significant contributions of many individuals at the Centre. In this report we introduce you to the people at Prairie Swine Centre and beyond who actually 'make it happen'.

The concepts and results are developed by the Research Scientists, Harold Gonyou, Stéphane Lemay, and Ruurd Zijlstra, their technicians and graduate students. Each of our scientists dedicates 20% of their time to technology transfer. This includes writing in this Annual Research Report, Centred on Swine newsletter, participating in meetings, symposia and the Satellite Conference plus answering the individual concerns of pork producers who inquire about application of new research on their own farm. Our Operations Manager, Brain Andries, accommodates the many visitors and tours that we host each year to increase awareness and application of our research. These tours often include a significant portion of their day in the barns with producers, students and industry specialists. Getting answers out quickly is important as farm decisions are often based on what is the most current knowledge on the subject, making sure publications are available, documents faxed and the library kept current is the responsibility of our receptionist Audrey McFarlane who's enthusiastic voice greets each call.

The list of supporting corporations is shown on page 15 & 22. This group has grown dramatically over the years as demonstrated in Figure 1, and represents a broad cross section of suppliers. Prairie Swine Centre Inc. is a small organization, when compared to other organizations which market their products and services to pork producers. Our goal is to partner with these providers to extend our reach into the barn and speed adoption of new knowledge. We do this through regular contact with your consultants. The veterinarians, engineers, feeding specialists, genetics and equipment suppliers are all important links to the industry. These innovators are some of the first to adopt our findings and include them as part of their product or service. By extension then we can do much more with the check-off dollars in technology transfer through partnering with the consultants who deal with pork producers regularly.

The following is a partial list of the activities organized by or participated in by Centre personnel during the past year. New ideas for 'making it happen' are always welcome.

Figure 1



World Pork Expo Study Tour 1998

Yearly Summary of Technology Transfer Activities

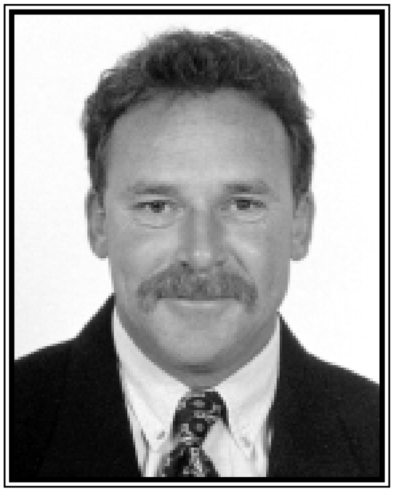
Category	Item	Circulation/attendance
Printed Material	Annual Research Report	2200
	Centred on Swine Newsletter	4,000 per issue
	Satellite Conference Proceedings	1,200 per year
	Survival Strategies Check List	7,200
Electronic Medium	Satellite Conference	600+
	Web Page	
Database	Environmental Issues funded by Ontario Pork	Developed in 1998,
Direct Producer Contact	Phone 300+ calls per year for technical information, farm visits	
Symposiums/meetings/trade shows	Saskatchewan Pork Industry Symposium /and Pork Expo	400+/ 800
	Manitoba Swine Seminar and Manitoba Hog Days	
	Banff Conference and Alberta Pork Congress	
	Ontario Pork Congress Herdsman's Night	300
	Annual Meetings of pork producers organization in each prairie province	
	Annual Tour including 2 meetings for Hutterite Bretheren	6 meetings in SK, AB
Articles in Trade Magazines	Western Hog Journal, National Pork Farmer, PIGS	
Interviews in Media	Print - 15, Radio - 20, Television - 4	
Industry Support	Sask Pork research Committee, Symposium and Pork Expo planning committee, VIDO Swine Technical Group, SIAST training level I & II, AgInfonet Swine Industry Moderator,	
New Initiatives	Management Training Program, Agrifood Innovation Fund Manure Odour tours, video production and booklet,	

Thanks to the Following Cooperators and Volunteers

Alberta Agriculture, Food and Rural Development
Alberta Pork Producers Development Corporation
British Columbia Ministry of Agriculture, Fisheries and Food
Mission Community Skills Centre, Mission, BC
Saskatchewan Department of Agriculture and Food
Maple Creek Learning Centre, Maple Creek, SK
Pork Central (Saskatchewan)
SPI Marketing Group (Saskatchewan)
Wascana Institute, SIAST
Manitoba Pork Est.
Manitoba Department of Agriculture
Ontario Pork Producers Marketing Board
Ontario Ministry of Agriculture, Food and Rural Affairs
P.E.I. Department of Agriculture
New Brunswick Department of Agriculture
Nova Scotia Department of Agriculture
Kentville Agriculture Centre
Newfoundland Department of Fisheries, Food and Agriculture
Université Laval, Québec
Centre de Developpement du Porc du Québec Inc.

We would like to extend our appreciation to all those **individuals and businesses** that helped to organize local sites.

OPERATION MANAGER'S REPORT



Brian Andries
Operation Manager

Since the start of this fiscal year, there have been no indications of any residual effects from PRRS, on either the breeding herd or nursery and grow-finish animals. Pre-weaning mortality is as low as it has ever been, and production inefficiencies like increased days to market, can be attributed to extra animal movement for research purposes, and overcrowding from increased production. Pigs weaned per mated female is averaging 25.76 for 'normal" production, definitely a good indication of things to come this year.

From all indications, the decision not to vaccinate the herd for PRRS, under the advice of Dr. Chuck Rhodes, was a good one. The reason was that knowledge and experience at the time was limited on both the safety and efficacy of the available vaccines. To date the herd has performed very well, based both on overall health and productivity. We have done some followup serological testing and plan to do more the next year. Finally, the decision also saved considerable money in vaccines and labor. Because we did not introduce any additional strains of the virus through vaccination, we will be able to study the so called " genetic drift " of the virus in the herd over time.

As previously mentioned, overall herd productivity has increased resulting in a need to contract finish a certain percentage of our grow-finish animals. The fact that we started 58 separate experiments in 1998 and used 5,692 animals for these trials, puts a huge strain on available space to effectively run experiments. Contract finishing allows us to more efficiently control animal and room schedules as it frees up space so that we can avoid moving and mixing animals. This also has the effect of increasing market performance by allowing us to strategically ship according to appropriate live weight and also decreases days to market.

Prairie Swine Centre has committed itself to full participation in the Canadian Pork Council Quality Assurance program. The program will be incorporated into our Standard Operating Procedures and training sessions. We have also set up an Occupational Health and Safety Committee at the Centre which will be responsible for bringing all health and safety concerns for staff working in an intensive livestock operation. Training programs in conjunction with safety will be established for all employees.

The increase in still births and mummified piglets, and an increase in weak piglets born, is reflected in the production figures summarized in the following table (Table1):

Table 1. Production parameters for the 1996/1997 and 1997/1998 fiscal years

	1996/1997	**1997/1998**
Sows farrowed, #	688	698
Farrowing rate, %	90.1	90.8
Pigs born alive/litter	11.4	10.8
Litters weaned	687	686
Pigs weaned	7142	6615
Weaned/female inventory	25	23.9

Please note that the impact from PRRS was mainly felt at the start of fiscal year 1997/1998 and the effect on the numbers of animals sold is quite significant. As previously discussed, production performance at the present time is back to normal up to 25.76 pigs weaned per mated female.

FIVE YEAR OBJECTIVES

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

Objective 1:

To define optimum feeding and management procedures to reduce the cost of feeding out grower-finisher pigs (20 kg to market) by at least $2.00 per head.
Feed is the single largest expense in commercial pork production; there is tremendous opportunity to significantly reduce the cost of production by defining cost-effective feeding strategies that focus on the biology of the pig. Optimum nutrition at the least cost occurs when we are neither overformulating nor underformulating diets. Projects in this area include investigation into phase feeding, split sex feeding and defining requirements based on lean tissue growth rates (genetics).

The underlying objective here is the development of feeding programs that focus on maximizing net profit as opposed to maximizing average daily gain or achieving the best index.

Objective 2:

To increase the value and use of opportunity feeds in swine diets.
In order to increase the use of locally grown commodities as ingredients in practical swine diets, the feeding value or the levels of available nutrients in these opportunity ingredients will be determined in digestibility studies. The maximum inclusion rate of opportunity ingredients in swine diets will be determined using feed intake and animal performance studies. Again, the objective is to maximize net income. The central question will be "how can these ingredients be used effectively to reduce the overall cost of production?" rather than "how much can be added to the diet without affecting performance?"

Objective 3:

To develop animal care guidelines through consideration of animal behaviour.
The evolving science of animal behaviour is used to determine how the physical and social environment affects the productivity and well-being of the pig. The underlying objective is to define management procedures that are good for both pigs and people.

Objective 4:

To develop systems for improving air quality inside hog barns, for health and productivity of pigs and people, and to reduce external odour emissions.
Air quality affects performance of livestock and stockpersons. Research in this area deals with all aspects of air quality including temperature, humidity, gases and dust. Research into new methodologies for reducing odour from inside the barn and from manure storage areas is a growing aspect of the engineering research program.

Objective 5:

To reduce the costs of production by optimizing the physical environment in commercial barns.
Currently, pork producers spend large amounts of money to build and operate facilities in order to achieve a certain interior barn environment. Optimizing this physical environment will avoid the cost of over-building while at the same time identifying weaknesses in our current designs. These studies will help to bring together the true needs of the pig (e.g. temperature, humidity, space, etc.) and the construction and operating specifications of the barn.

PROPOSED RESEARCH FACILITY

Prairie Swine Centre Inc. (PSCI) of Floral, Saskatchewan has embarked on a major initiative, including plans for the construction of new facilities to expand its research capabilities in the areas of production efficiency, environmental issues and animal well-being.

The Site

The location of the new facility has not yet been finalized, but a potential site near Elstow, Saskatchewan is being considered. The new unit will not replace, but rather compliment the current facilities near Floral. It will consist of 4 parts:

- The main research unit - a 600 sow farrow-to-finish facility
- A small off-site unit about 1 mile from the main building site
- A feed mill, and
- A residence for the manager

Community Benefits

The new facility will offer important benefits to the local community:

- Permanent, full-time employment for 5 people
- Additional casual employment as required
- A local market for 150,000 bushels of feed grains plus canola meal
- A local source of animal manure for use as fertilizer
- A market for various operational supplies and services, and
- Approximately 40 jobs created during construction

Expanding Research Capabilities

The new facility will increase the quantity and quality of research that the Prairie Swine Centre can offer the pork industry. Current facilities at Floral, Saskatchewan - built in 1980 and expanded in 1992 and 1995 - have not been able to keep pace with the demand for research to increase productivity. In addition, there is a growing need for research on environmental issues and animal welfare.

The new construction will provide the facilities needed, allowing the Centre to broaden its research capability and increase the speed with which research can be completed.

Producer-Driven Research

In an industry undergoing constant change, research is the key to remaining competitive in the global marketplace. The Prairie Swine Centre consults regularly with the pork industry to make sure its research program is meeting the needs of its constituency. Whether a pork producer has a large or small operation, or uses new or older facilities, the Centre seeks a balanced approach to research to ensure benefit to all.

Producer Funding Exclusively for Research

The new facilities will be paid for by a $3 million grant from Saskatchewan Agriculture and Food, as well as private loans. In this way, research funding from producers and government agencies will continue to be used exclusively for research and not for bricks and mortar. In 1992, when producer check-off funding was initiated, the Centre promised that their funds would be used only for research and technology transfer. That commitment remains in effect.

Commercial Operations

The new facilities will be constructed along commercial lines to create a research unit that closely reflects barns being built and used by today's pork industry.

All planning for the new facility has required that revenues from the sale of stock must be adequate to pay all expenses required to operate the facility as a pork production unit, including debt servicing. In this way, the new facility will operate very much like a commercial farm . . . but with experiments carried out alongside normal production activities.

Want More Information?

The Prairie Swine Centre is committed to keeping all stakeholders fully informed about the new facility and to answer any questions that may arise. The following information sheets are currently available and others will be added soon:

- Manure Management
- Feed Grain Utilization
- Popular Myths

If you would like copies of these information sheets, please contact our office or check our Web page.

Prairie Swine Centre Inc.
PO Box 21057 - 2105-8th Street East
Saskatoon, Saskatchewan S7H 5N9
Phone (306) 373-9922
Fax (306) 955-2510
Web: http:\\adminsrv.usask.ca/psci

Prairie Swine Centre Inc. located 10 km east of Saskatoon near Floral, Sk

RESEARCH REPORTS - LIST OF CONTRIBUTORS

Dr. H.W. (Harold) Gonyou
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Dr. M.L. (Mark) Lorschy
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Dr. C.F.M. (Kees) deLange
Dept. of Animal Science
University of Guelph
Guelph, ON
N1G 2W1

Tom A. Scott
Agriculture & Agrifood Canada
Agassie, B.C.

Dr. Ruurd T. Zijlstra
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Michael J. Edney
Grain Research Laboratory
Canadian Grain Commission
Winnipeg, MB

Mary Lou Swift
Agro Pacific Industries Ltd.
Chilliwack, B.C.

Dr. Ernie Barber
Agricultural Bioresource Engineering
University of Saskatchewan
Saskatoon, SK
S7N 0W0

Dr. Shaoyen Li
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Dr. Huiging Guo
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Mr. Lloyd Zyla
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Mr. Colin Peterson
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Dr. Stéphane Lemay
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Dr. J.F. (John) Patience
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Mr. D.A. (Doug) Gillis
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Dr. R. (Ruurd) Zijlstra
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Mr. D. Lee Whittington
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

Dr. E. (Eduardo) Beltranena
Prairie Swine Centre
P.O. Box 21057
2105 - 8th Street East
Saskatoon, SK
S7H 5N9

BIOLOGICAL VARIABILITY & CHANCES OF ERROR

Variability among animals in an experiment leads to problems in interpreting the results. Animals on treatment X may have higher average daily gains than those on treatment Y, but variability within treatments may indicate that the differences in production between X and Y were not the result of the treatment alone. Statistical analysis allows us to calculate the probability that such differences are from treatment rather than chance.

In some of the articles herein, you will see the notation "P,.05." That means the probability of the differences resulting from chance is less than "1 chance in 20" or 5%. If two averages are said to be "significantly different", the probability is less than "1 chance in 20" (5%) that the difference is from chance, or the probability exceeds 95% that the difference resulted from the treatments applied.

Some papers contain correlations or measures of the relationship between traits. The relationship may be positive (both traits tend to get larger or smaller together) or negative (as one trait gets larger the other gets smaller). A perfect correlation is one (+1 or -1). If there is no correlation the relationship is zero.

In other papers you may see an average given as 2.5+- .1. The 2.5 is the average; .1 is the "standard error". The standard error is calculated to be 68% certain that the real average (with unlimited number of animals) would fall within one standard error from the average, in this case between 2.4 and 2.6.

Many animals per treatment, replicating treatments several times, and using uniform animals increase the probability of finding real differences when they exist. Statistical analysis allows more valid interpretation of the results, regardless of the number of animals. In all the research reported herein, statistical analysis are included to increase the confidence you can place in the results.

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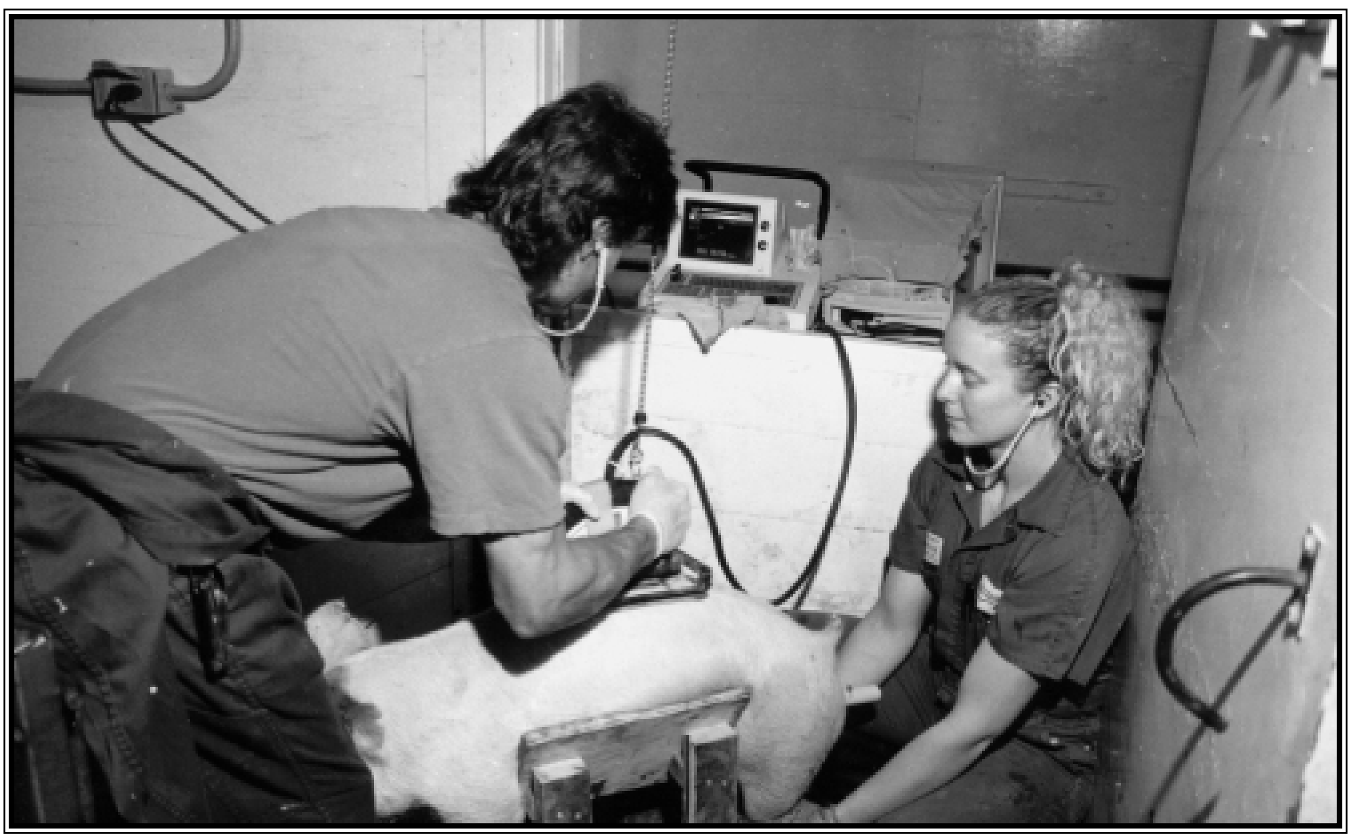


Technicians Doug & Allison Orr taking realtime ultrasound images to determine lean and fat deposition on grower pigs

NUTRITIONAL VALUE OF WHEAT II

RELATIONSHIP OF DE CONTENT OF WHEAT WITH NON-STARCH POLYSACCHARIDES

Ruurd T. Zijlstra, C.F.M. (Kees) de Lange, and John F. Patience

SUMMARY

A large range exists in the digestible energy (DE) content of grains such as barley, field peas and wheat. The variability in DE content of wheat was described in the 1993 Annual Report, and equations to predict DE content were developed based on basic chemical characteristics. The specific objective of this study is to relate DE content of the same wheat samples with the non-starch polysaccharide content.

The DE ranged from 3330 to 3645 kcal/kg (90% DM); thus, the difference in DE content between the highest and lowest value was 9%. Of the analysed chemical characteristics, xylose, a non-starch polysaccharide (NSP), had the highest correlation with DE, and was thus the single best predictor for DE content. The results indicated that prediction of nutritional value is more accurate based on chemical characteristics than based on density. Further research is warranted to better describe the effects of NSP on digestibility of gross energy (GE) and other nutrients.

INTRODUCTION

In the 1993 Annual Report, of all analysed characteristics, fibre described as crude fibre, neutral-detergent fibre (NDF) or acid detergent fibre (ADF), was most closely related to DE content of wheat. Recent advances in analytical techniques have resulted in a more precise characterization of the fibre fraction, in particular the non-starch polysaccharides (NSP) such as xylose and arabinose. These NSP are more complex carbohydrates that pigs cannot digest with their own enzymes. Thus, the specific objective of this study was to relate DE content of wheat with NSP.

EXPERIMENTAL PROCEDURES

Fifteen wheat samples that were expected to differ in DE content were collected in Saskatchewan. The wheat samples were analysed in growing pigs for DE content and in the laboratory for physical and chemical characteristics such as density (bushel weight) dry matter, energy, crude protein (CP), amino acids, starch, crude fibre, ADF, NDF, and the various NSP. The results were statistically re-analysed including the new NSP results, to develop the best relationship of a single chemical characteristic and DE content of wheat.

RESULTS AND DISCUSSION

In the 15 wheat samples, fibrous components had a negative correlation with DE content, while the correlation of CP with DE content was positive. Total xylose content had the highest correlation of any characteristic with DE content (-0.78), followed by total NSP (-0.74), CP (0.72), total arabinose (-0.71) and NDF and ADF fractions (-0.70). Density was correlated positively with DE content (0.65); however, in the 12 wheat samples with a density between 65 and 80 kg/hL, density was not correlated with DE content. The correlation coefficients suggest that fibrous components predominantly determine the DE content of wheat.

The relationship between total xylose, GE and DE content in wheat is illustrated in Figure 1. Although GE content is fairly consistent among the 15 samples, a large range in DE content exists. Three of the four wheat samples with a total xylose concentration above 5.5% were the three wheat samples with the lowest DE content in the study. Total xylose concentration is clearly one of the factors that contributed negatively to a reduced DE content.

IMPLICATIONS

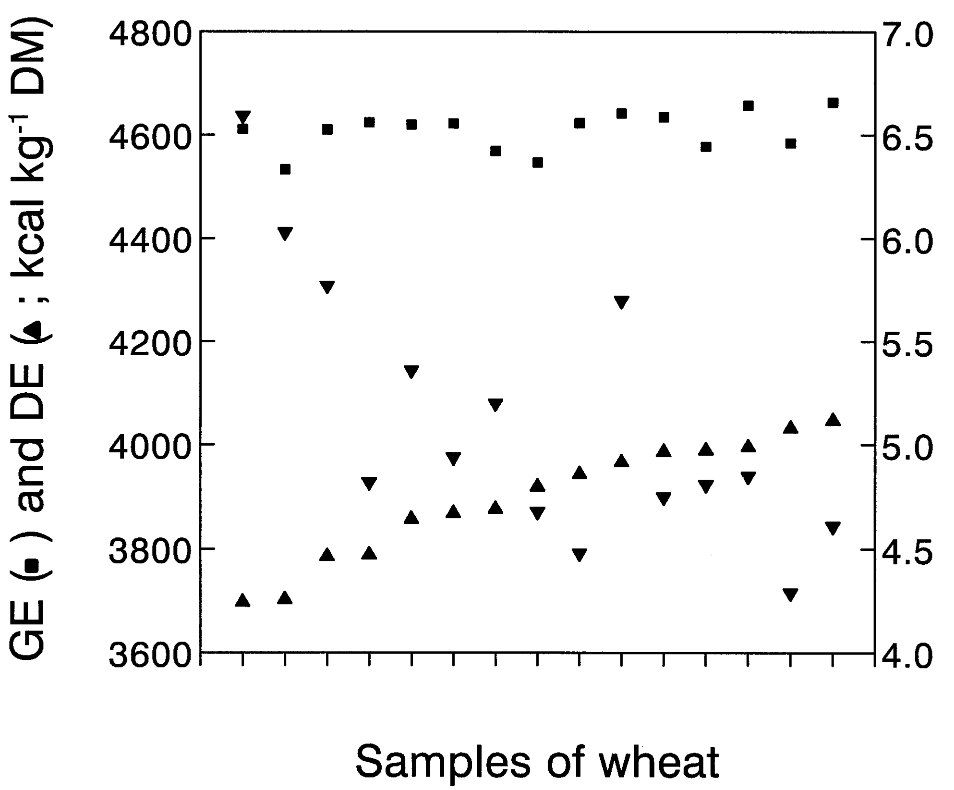
The results of the study indicate that the range in wheat DE content might be predicted best by the NSP content of wheat or the content of a specific NSP, xylose. The results do not prove that fluctuating NSP concentrations cause the range in DE content.

ACKNOWLEDGEMENTS

C.F.M. de Lange is currently an Associate Professor in the Department of Animal and Poultry Science at the University of Guelph.

The presented work was supported financially by the Canadian Feed Industry Association and pork producers from Saskatchewan, Manitoba and Alberta.

Figure 1. Gross energy (GE) and digestible energy (DE) content and total xylose concentration in 15 wheat samples. Samples were sorted from left to right with increasing DE content. Among the 15 samples, GE content is fairly consistent with a large range in DE content. Total xylose concentration is clearly one of the factors that contributed negatively to a reduced DE content.



NUTRITIONAL VALUE OF FIELD PEAS II

PERFORMANCE OF GROWER PIGS FED DIETS ADJUSTED FOR FIELD PEA DE CONTENT

Ruurd T. Zijlstra and John F. Patience

SUMMARY

Field peas are used increasingly as a source for protein and energy in swine rations in Western Canada. The variability of the DE content of field peas has been described in the 1997 Annual Report. The objective of the present study is to determine the effects of increased knowledge of nutritional value on animal performance.

The DE content in 11 field pea samples ranged from 3098 to 3739 kcal/kg. The specific objective of this study was to reach equal performance among growing pigs fed the described field pea samples. Thus, 30% field pea diets were formulated with equal DE, protein, and total amino acid content (3300 kcal DE, 16.3 % CP, and 0.92% total lysine). Minimal differences were observed in average daily feed intake and subsequent pig performance among the 11 field pea diets, indicating that re-formulation of diets using known values for DE content resulted in fairly equal pig performance. More detailed knowledge of ingredient composition is needed to obtain uniform pig performance.

INTRODUCTION

Recent research results indicate that locally grown feed ingredients express a high variability in nutritional value for grower-finisher pigs. The highest and lowest DE value differed 20% within eleven samples of field peas grown on a single quarter of land in central Saskatchewan (Figure 1). Field peas are becoming an increasingly important protein and energy source for grower-finisher pigs in Western Canada. However, benefits to address the range in nutritional value have been poorly assessed. Thus, the specific objective of this study was to reach equal performance among pigs fed eleven field pea samples that differ in DE content.

EXPERIMENTAL PROCEDURES

Thus, 30% field pea diets were formulated with equal DE, protein, and total amino acid content (3300 kcal DE, 16.3 % CP, and 0.92% total lysine). A diet including barley, wheat, and soybean meal with an identical nutrient content was considered the overall control diet. Each diet was consumed freely for 28 days by 6 grower pigs (3 barrow/3 gilt), housed individually with an overall weight range of 29 to 56 kg.

RESULTS AND DISCUSSION

Minimal differences were observed in average daily feed intake among the 11 field pea diets (Figure 2), indicating that re-formulation of diets using obtained values for content of DE resulted in fairly equal intake. Furthermore, intake of the control diet was not different than any of the field pea diets, indicating that field peas are excellent to be included as ingredient in diets for growing pigs. Palatability of field peas seems a lesser issue than thought previously. Average daily gain (Figure 3) or feed efficiency (Figure 4) seemed reduced for three of the 11 field pea diets, indicating that factors in field peas other than DE, crude protein and total amino acids content might influence performance.

IMPLICATIONS

Nutritional value (quality) of locally produced grains is becoming an important issue for the pork industry. Not all the field peas produced will be of an identical quality, which is acceptable, as long as the nutritional value of a particular batch of field peas can been identified. Correct assessment of nutritional value of specific batches of field peas will enable correct pricing and allow reformulation of diet to animal requirements. Cost of production and the environmental impact of the pork industry can thereby be reduced. Determination of nutritional value of field pea should have implications for pricing, diet re-formulation, and subsequent uniformity of performance.

ACKNOWLEDGEMENTS

Mr. Leon Lueke in Humboldt, SK, who grew and harvested the 11 field pea varieties and donated samples to PSCI for research purposes, initiated the project.

The presented work was supported financially by the SPI Marketing Group and the Agriculture Development Fund of the Saskatchewan Department of Agriculture and Food. The pork producers of Saskatchewan, Manitoba and Alberta are acknowledged for their strategic support of PSCI.

Figure 1. The digestible energy content of 11 field pea samples.

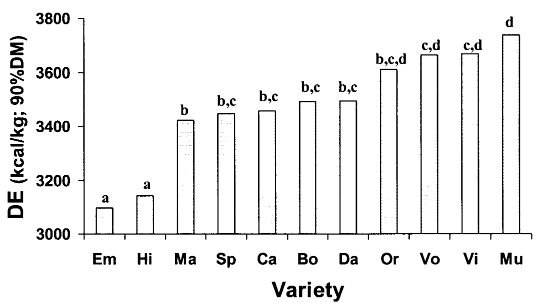
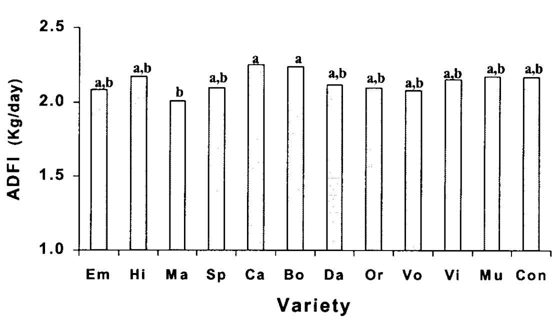


Figure 2. Feed intake of growing pigs fed diets adjusted for field pea DE content and a wheat-barley-soybean meal control diet.



diets adjusted for field pea DE content and a wheat-barley-soybean meal control diet.

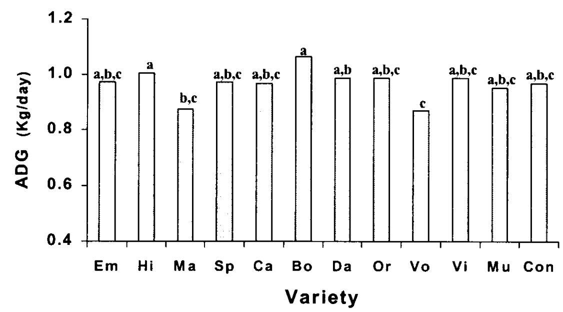
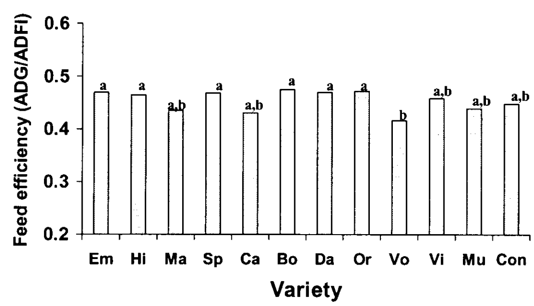


Figure 4. Feed efficiency of growing pigs fed diets adjusted for field pea DE content and a wheat-barley-soybean meal control diet.



ANALYSIS OF BARLEY DE

MEASUREMENTS TO PREDICT SWINE DE CONTENT OF BARLEY

Ruurd T. Zijlstra, Tom A. Scott, Micheal J. Edney, Mary Lou Swift, and John F. Patience

SUMMARY

A significant range in DE content exists in western Canadian barley, which results in a large range in economic value. Physical parameters can not be used to estimate the DE content in barley. Equations based on chemical characteristics can predict DE content accurately. Broiler AME and swine DE are not correlated; however, addition of enzymes to broiler diets improved the correlation between AME (+ enzyme) and DE greatly. Finally, the results indicate that barley DE can be predicted accurately by NIRS; however, a larger sample set is required to increase robustness of calibration.

INTRODUCTION

A good understanding of the nutritional value of ingredients included into swine diets is becoming increasingly important. Reasons include the improved definition of nutrient requirements across various environmental conditions, the increased attention on pork quality and the necessary reduction of nutrients excreted in swine manure. The presentation was based in part on a collaborative research project that explored a range of measurements to predict digestible energy (DE) of barley for pigs. The focus within nutritional value was DE, because the greatest cost pressure with least-cost diet formulation is against supply of available energy. The overall project had three objectives: (1) explore if a range in DE exists in western Canadian barley, (2) attempt to calculate the corresponding range in economic value, and (3) explore physical and chemical measurements, chicken available metabolisable energy (AME), and near-infrared spectroscopy (NIRS) to predict DE of barley for pigs.

RANGE IN DE

In total 40 barley samples were analysed for swine DE in 2 trials in grower pigs (30-40 kg) housed in metabolism crates that allowed collection of faeces. Trial 1 included 20 samples without damaged kernels (see Fairbairn et al., 1997 Annual Report), whereas trial 2 included some "off-grade" (sprouted, frost-damaged) samples. Overall, DE ranged from 2686 to 3163 kcal/kg (90% DM). Experimental diets included a specific barley sample (96%), vitamins, minerals, and chromium oxide as an indigestible marker. Dry matter, energy and chromium content were analysed in experimental diets and collected faeces to calculate DE content for each barley sample.

RANGE IN ECONOMIC VALUE

For the 20 barley samples from trial 1, the economic value for a typical diet for grower pigs was calculated using the feed formulation software Brill (see Fairbairn et al., 1997 Annual Report). The economic value was calculated as follows: a diet was formulated for grower pigs using the average DE content (2940 kcal/kg) and price ($110/1000 kg) of barley, and with prices for other ingredients in July 1997. Then, this diet was reformulated using the actual DE content of each barley sample to reach the DE content of the original diet. Finally, the value of barley was adjusted to reach the cost price for the original diet. Each diet contained a minimum of 45% barley. Using these calculations, value of the barley samples ranged from 78 to 139 $/1000 kg, a range of $61.

PREDICTION OF DE

Physical and chemical measurements, chicken AME, and NIRS were analysed to predict DE of barley for pigs.

Physical measurements. Density, described as test weight or bushel weight, remains in use throughout the grain and livestock industry as an indicator of "quality." Some studies have suggested a positive relationship between density and nutritional value of barley. However, a large body of scientific literature indicates that the prediction of DE with physical measurements should be treated with great skepticism. Likewise, density ranged from 47.9 to 71.5 kg/hL or 38 to 57 lb/bushel in the present study (Figure 1) and was not related to DE (R^2 = 0.14), indicating that physical measurements can not predict DE accurately.

Chemical measurements. A wide range of chemical components was analysed in the barley samples from trial 1 (see Fairbairn et al., 1997 Annual Report), including components of standard proximate analysis and non-starch polysaccharides (NSP). Starch was positively correlated to DE (r = 0.64; $P < 0.01$), whereas crude fibre, neutral detergent fibre, and acid detergent fibre (ADF) were negatively correlated to DE (r = -0.83, -0.82, -0.92, respectively; $P < 0.01$). Of the chemical components, ADF concentration was the best single predictor for DE in trial 1 (DE=3526 - 92.8 x ADF (90% DM); R^2 = 0.85; $P < 0.01$), indicating that chemical parameters can predict DE accurately.

Chicken AME. Barley samples were analysed by an AME-bioassay in broiler chicks modified by Tom A. Scott, in diets with and without supplemental enzymes. Without enzymes, AME and DE were not related (R^2 = 0.03; Figure 2), but the relation improved greatly by enzyme supplementation (R^2 = 0.56; Figure 3). These results indicate clearly that chicken AME can currently not be used to predict swine DE in barley. Chicken AME might be considered a worthy approach to study swine DE, but only after enzyme supplementation is modified to further increase the relation between swine DE and chicken AME (e.g., $R^2 > 0.90$). Recent research at PARC indicates that feed intake and subsequent performance of chickens differs greatly among barley samples, an interesting observation that needs to be verified in swine.

NIRS. So far, Dr. Robert J. van Barneveld in Australia has developed the best calibration for swine DE content in cereal grains. With a sample set of 156 samples, DE in whole grain cereals could be predicted to an accuracy of 90 kcal/kg. In the present study, ground kernel barley samples were analysed by NIRS (400-2500 nm, 2 nm intervals). A good calibration was developed using 27 ground samples (R^2 = 0.96; SE of prediction (SEP) = 30.47) to predict DE in 12 other ground samples (R^2 = 0.98; SEP = 24.0). A similar calibration was developed with whole kernel samples (R^2 = 0.94; SE of cross validation (SECV) = 87 kcal/kg), indicating that NIRS can predict DE content of barley fairly accurately.

Apart from NIRS calibrations for nutritional value per kg of cereal grains, successful calibrations for feed intake and subsequent performance in chickens indicate further benefits of NIRS have been developed by Mary Swift et al.

IMPLICATIONS

The results of the present study indicate that the nutritional and economic value of barley grown in Western Canada differs tremendously. Physiological parameters or chicken AME are not useful predictors for swine DE. Chemical parameters and NIRS are useful predictors for swine DE. Further work is necessary to strengthen the NIRS calibration prior to commercial application.

ACKNOWLEDGEMENTS

Tom A. Scott is a Research Scientist at the Pacific Agriculture Research Centre of Agriculture and Agri-Food Canada at Agassiz, BC. Micheal J. Edney is a Program Manager at the Grain Research Laboratory of the Canadian Grains commission at Winnipeg, MB. Mary Lou Swift is the Manager - Research and Technical Services at Agro Pacific Industries Ltd. at Chilliwack, BC. Shawn L. Fairbairn conducted the initial barley work (see 1997 Annual Report). Dr. Brian Rossnagel (Crop Development Centre, Saskatoon) provided valuable input to keep the project focused.

The presented work was supported financially by pork producers from Saskatchewan, Manitoba and Alberta, Saskatchewan Agriculture Development Fund, Alberta Barley Commission, Western Grains Research Foundation, BC Chicken Marketing Board, and Agriculture and Agri-Food Canada.

Figure 1. Plot of digestible energy (DE) versus density reported as bushel weight for 40 barley samples (R^2 = 0.14). There is no correlation between density and DE; therefore, bushel weight is an extremely poor indicator of nutritional value.

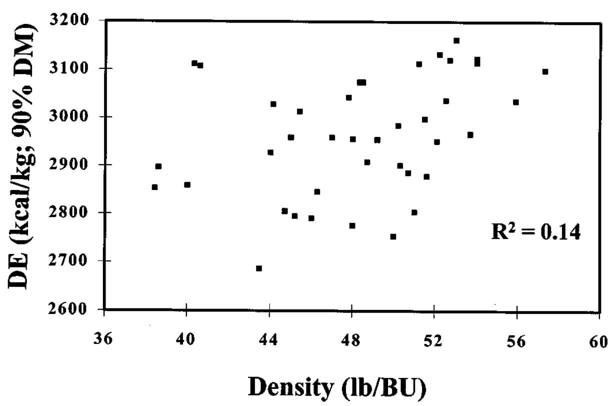


Figure 2. Plot of swine DE versus chicken AME for 40 barley samples (R^2 = 0.034). There is no correlation between DE and AME; therefore, chicken AME is an extremely poor indicator of nutritional value of barley for swine.

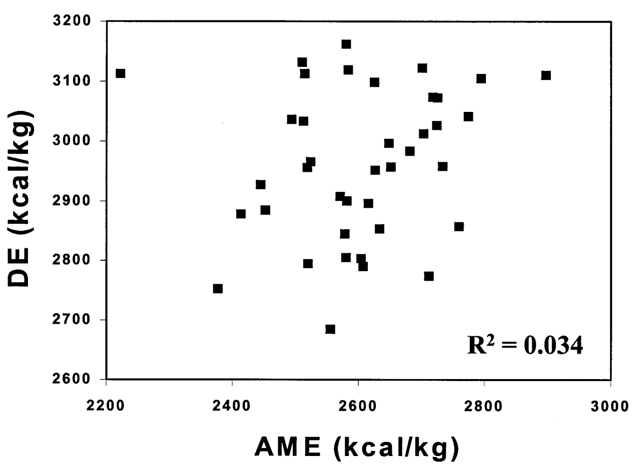
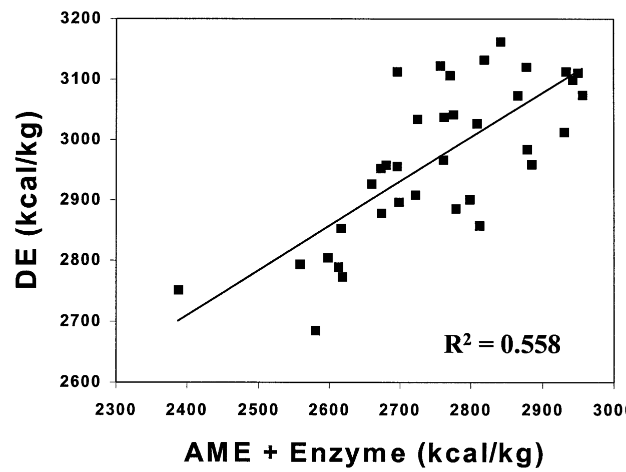


Figure 3. Plot of swine DE versus chicken AME + enzyme for 40 barley samples (R^2 = 0.558). Enzyme addition to chicken diets improved the correlation between AME and DE. However, further improvements are needed if chicken AME is to become an useful indicator of nutritional value of barley for swine.



CANOLA MEAL AND ENZYME SUPPLEMENTATION

EFFECT OF ENZYMES IN WHEAT-CANOLA MEAL DIETS ON PERFORMANCE AND NUTRIENT DIGESTIBILITY IN WEANED PIGS

Ruurd T. Zijlstra, Shaoyan Li, and John F. Patience

SUMMARY

Carbohydrases in 25% canola-meal diet consumed freely by weaned pigs: increased daily gain (up to 13%), increased feed intake (up to 16%), did not affect feed efficiency, reduced viscosity of digesta in ileum, and did not affect nutrient digestibility.

Beneficial effects of enzyme supplementation to a wheat-canola meal diet fed to weaned pigs were not related to improved nutrient digestibility, but rather to increased feed intake. The increase in feed intake is hard to explain directly. However, reduced viscosity of digesta in the distal small intestine suggests that increased feed intake is related to an increased passage rate.

INTRODUCTION

The nutritional value of canola meal for pigs is lower than soybean meal (SBM). The digestible energy (DE) content is 14% lower in canola meal than in SBM. Gross energy (GE) content of canola meal is similar to SBM; but high concentrations of fibrous components seem to limit digestibility and availability of energy. Crude fibre content is three times higher in canola meal than in SBM. The NSP concentration in canola meal is high, with cellulose and arabinose as the major components.

Supplemental enzymes are becoming popular to overcome limitations of pigs to digest NSP such as fl-glucans and arabinoxylans. In pigs, faecal digestibility of NSP and the nutrients they enclose is higher than ileal digestibility, because of microbial degradation in the hindgut. Energy and protein fractions digested in the large intestine have less metabolic value compared to nutrients digested and absorbed in the small intestine. Thus, supplemental enzymes to degrade NSP might improve digestibility of NSP and the enclosed nutrients at the ileum and thereby increase nutrient utilization.

The objective of this study was to improve the nutritional value of a canola meal diet for weaned pigs with supplemental enzymes.

EXPERIMENTAL PROCEDURES

Ninety-six 21-day-old pigs (48 barrows and 48 gilts) were weaned at 3 weeks and housed in an all-in-all-out nursery with slotted floors. For 7 days, pigs had free access to a regular phase-1 diet.

After acclimation, six pens were assigned to four diets for 28 days, for 24 pigs per diet. A wheat-canola meal diet was formulated to contain 3.15 Mcal DE/kg and a digestible lysine to DE ratio of 3.35 g/Mcal (Figure 1). Vitamins, minerals and amino acids were supplemented to meet nutrient requirements. Chromic oxide was included to mark digestibility. An enzyme premix (Finnfeeds International) containing fl-glucanase and xylanase was added to the basal diet at 0, 1, 2 and 4 g/kg to create four experimental diets. Pigs had free access to feed and water. Diets were offered in mash form.

To study growth performance, pigs were weighed at weaning, and every 7 days until the end of the experiment. Feed intake was measured every 7 days.

To study nutrient digestibility, 6 pigs per diet were euthanised to collect digesta. Digestibility was studied in small intestine digesta as opposed to in faeces, because total tract digestibility might conceal effects of supplemental enzymes. To mimic commercial practice and maximize feed intake, pigs were not cannulated but slaughtered to collect digesta. Immediately after digesta collection, pH and viscosity were determined. Diet and digesta were analysed for DM, ADF, NDF, chromium oxide, and GE. Nutrient digestibility was calculated using chromium oxide concentrations in diets and faeces.

RESULTS AND DISCUSSION

Performance. Average daily gain (ADG) increased quadratically ($P < 0.05$; Figure 2) for the entire experimental period. Numerically, pigs fed the diet supplemented with 2 g enzyme/kg diet had the highest ADG. Supplementation of 2 g enzyme/kg diet increased ADG 53 g/d (13%) compared to the control diet ($P < 0.05$). More specifically, ADG increased quadratically for days 8-14 ($P < 0.05$). Treatment differences were not observed for other weeks.

Average daily feed intake (ADFI) of weaned pigs increased quadratically ($P < 0.05$; Figure 2) for the entire experimental period. Numerically, pig fed the diet supplemented with 2 g enzyme/kg diet had highest ADFI. Supplementation of 2 g enzyme/kg diet increased ADFI 100 g/d (15%) compared to the control diet ($P < 0.05$). More specifically, ADFI increased quadratically for days 1-7 ($P < 0.10$) and days 8-14 ($P < 0.05$) and linearly for days 1-7 ($P < 0.10$) and days 22-28 ($P < 0.10$). For days 15-21, dietary treatments were not different.

Feed efficiency was altered by enzyme supplementation for the entire experimental period ($P > 0.10$). Only for days 1-7, feed efficiency was reduced linearly ($P < 0.05$; Figure 3) with an increase in enzyme supplementation.

Nutrient digestibility. Enzyme supplementation did not alter nutrient digestibility for any section of the small intestine (Figure 4). Digestibility of NDF improved linearly with enzyme supplementation (Figure 4; $P < 0.12$). Digestibility values for ADF were low and the negative digestibilities suggests that pigs failed to utilize ADF even with supplemental enzymes.

Enzymes did not alter digesta pH. Viscosity was 30% reduced at the ileum with enzyme supplementation at 4 g/kg ($P < 0.05$; Figure 5).

IMPLICATIONS

The results of the present study indicate that nutritional value of wheat-canola meal diets can be improved by enzyme supplementation by increasing feed intake. This study studied effects of enzymes on nutrient digestibility in weaned pigs with free access to feed. Data indicated that nutrient digestibility was not affected by enzymes.

ACKNOWLEDGEMENTS

The authors acknowledge the financial assistance for the project provided by the Canola Council of Canada, Finnfeeds International, Saskatchewan Canola Development Commission, and the Program for Export Market Development.

The pork producers of Saskatchewan, Manitoba and Alberta are acknowledged for their strategic funding to Prairie Swine Centre Inc.

Figure 1. Composition of the control diet.

BASAL DIET: Ingredients

Wheat	65.1
Canola meal	25.0
Casein	3.5
Limestone	1.3
Dicalcium phosphate	1.2
Canola oil	1.0
Chromic oxide	0.3
* Misc.	2.6
TOTAL	100.0

* ASP 250, Vit. + Min. mix, Salt, L-Lys, L-Thr, L-Trp. Choline chloride

BASAL DIET: Nutrients

D.E., Kcal/kg	3150
Crude protein, %	21.7
Lysine, %	1.28
Methionine, %	0.43
T.S.A.A., %	0.88
Threonine, %	0.91
Calcium, %	0.94
Phosphorus, %	0.75
Sodium, %	0.20

Figure 2. Average daily gain and daily feed intake of weaned pigs fed wheat-canola meal diets supplemented with carbohydrases.

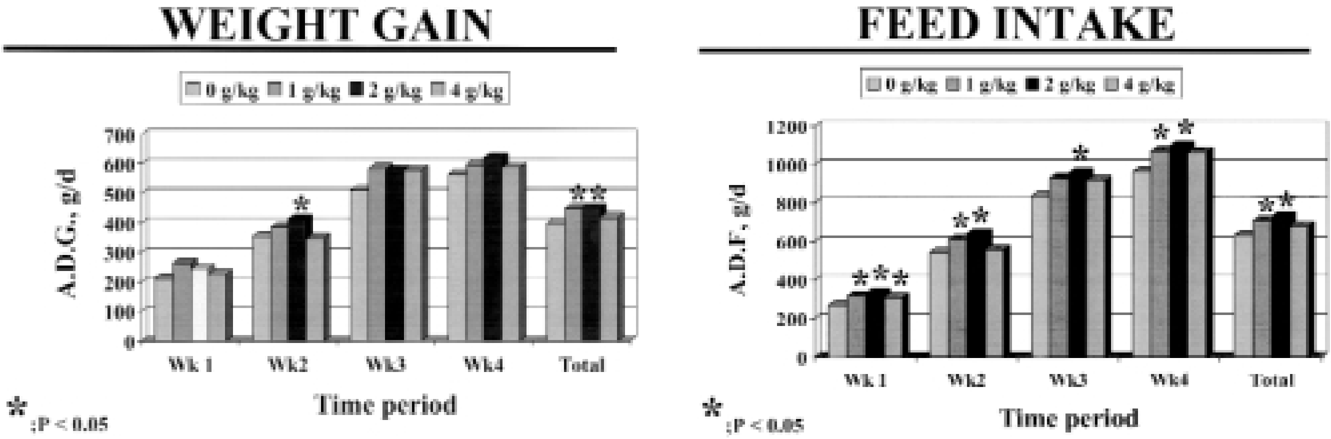


Figure 3. Feed efficiency of weaned pigs fed wheat-canola meal diets supplemented with carbohydrases.

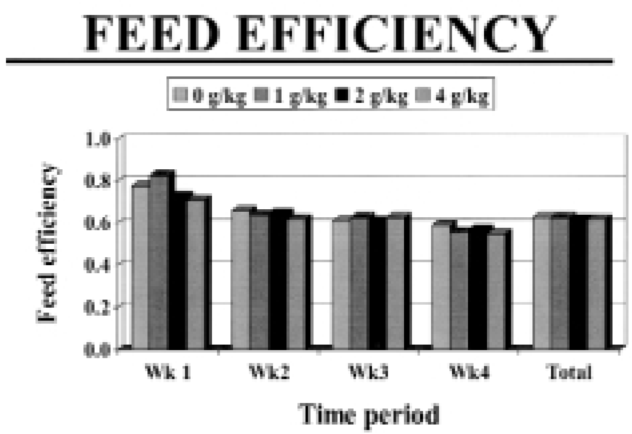


Figure 4. Digestibility of NDF and energy in small intestine digesta collected from weaned pigs fed wheat-canola meal diets supplemented with carbohydrases.

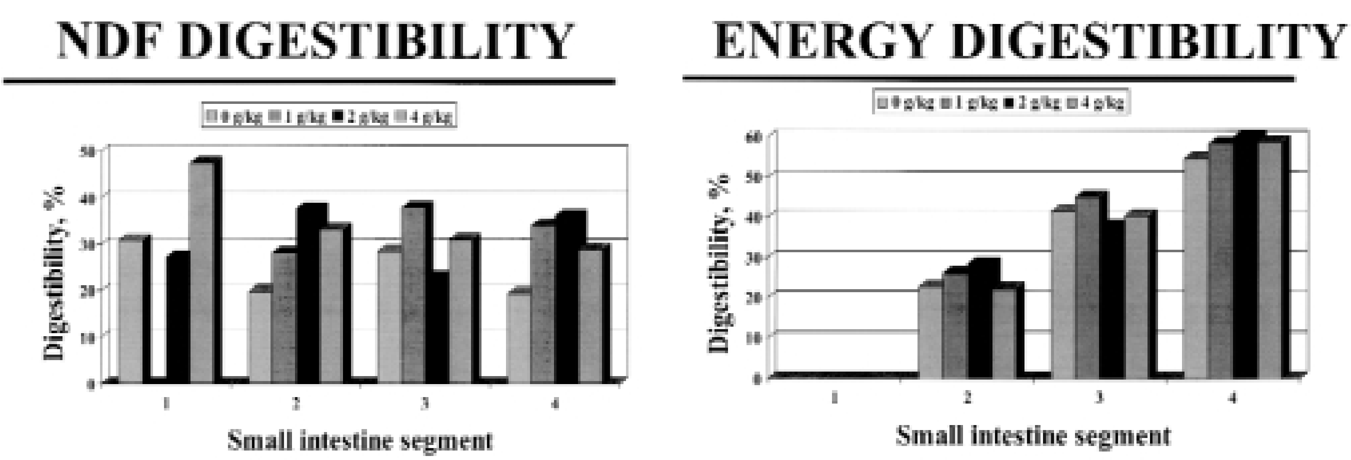
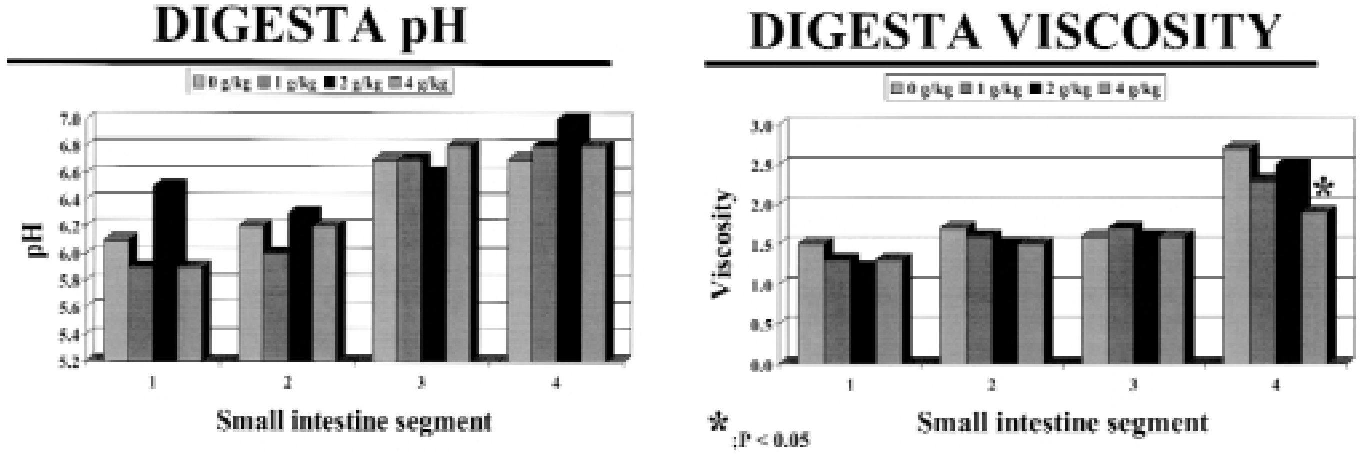


Figure 5. pH and viscosity NDF and energy in small intestine digesta collected from weaned pigs fed wheat-canola meal diets supplemented with carbohydrases.



Piglets in a Commercial Nursery

PRE-SORTING PIGS BY WEIGHT

PRE-SORTING PIGS BY WEIGHT FOR ALL IN/ALL OUT OR CONTINUOUS FLOW FACILITIES

Harold Gonyou and Colin Peterson

SUMMARY

Two trials were conducted to determine if pigs should be sorted by weight at the beginning of the growing/finishing phase and if this decision is dependent upon the use of all in/all out (AI/AO) or continuous pig flow management. Pigs were classified by their relative weight as Heavy, Medium or Light prior to allocation to pens. Within each gender, pigs were allocated to create uniform pens, consisting entirely of Heavy, Medium and Light pigs, respectively, and variable pens consisting of two or more of the weight classes. In addition to standard growth and intake data, behaviour data on aggression and time budgets were collected on the pigs.

There were no deleterious effects of having variable weight pens. Average daily gain (ADG), and behaviour did not differ between pigs in uniform and variable weight pens. The rate of pen and room emptying differed depending upon the pig flow management system and grouping strategy. Under a continuous flow system, pens were emptied in an average of 105.5 days, while under an AI/AO system the rooms were emptied in an average of 107.5 days. Uniform and variable weight pens emptied at the same rate under the continuous flow system. Under the AI/AO system, rooms of variable weight pens emptied faster (104.1 days) than did rooms of uniform weight pens (110.9). Sorting pigs by weight into uniform pens at the beginning of the growing/finishing phase is not advantageous, and may be detrimental to rapid turn-over of rooms under an AI/AO management system.

INTRODUCTION

The recommended practice is to sort pigs by weight when they enter the grower/finisher barn. This is due to the belief that creating pens of uniform weights results in greater uniformity at market, earlier emptying of heavy pens, and lighter pigs reaching market weight sooner. However, previous research has not consistently demonstrated such effects, and has suggested that the social behaviour of pigs may be more stable in non-sorted groups.

In continuous flow buildings new pigs are introduced when a pen is emptied, while in all-in/all-out (AI/AO) systems an entire room must be marketed before a new cycle or turn begins. The strategy in a continuos flow system should be to empty pens as soon as possible, while that in AI/AO systems is to get the smallest pigs to market sooner. In continuous flow systems it would seem advantageous to sort pigs by gender and weight so that entire pens reach market weights at the same time and pens can be refilled. However, in AI/AO, sorting by weight may be disadvantageous in that early-marketed pens remain empty while the remaining pigs are crowded into just a few pens. It may be better to place a full range of small to large pigs in each pen, resulting in a social environment with a well defined hierarchy, and pens with increased space for all small pigs once the first pigs are marketed. Thus, the decision to sort or not to sort by weight may be a function of continuous or AI/AO out management.

MATERIALS AND METHODS

Two trials were run with two replications in each trial. Each replicate included six pens of castrated males and six pens of females, with 12 pigs per pen. Within gender, pigs were classified as heavy (heaviest 33%), medium or light, and randomly assigned within weight class to create three uniform pens, consisting entirely of Heavy, Medium and Light pigs, respectively. Three variable pens were also created, each consisting of two or more of the weight classes.
Pigs were individually weighed on day zero (approximately 25 kg.), then at 2-wk intervals until week 10, and weekly thereafter. Pigs remained in their original pens until they reach market weight, in order to determine emptying time for each treatment. The pen emptying rate, used for continuous flow, was defined as the number of days required for 80% of the pigs in the pen to reach the targeted market weight of 107 kg. The room emptying rate, used for AI/AO, was defined as the number of days for 80% of pigs within a gender to reach the target market weight. Feed intake was determined for each pen on the same schedule as animal weights. Carcass data were collected and evaluated after each trial was completed.

Levels of aggression were observed by live observations on the day of re-grouping to determine the duration and frequency of fighting for each treatment. Observations were also made during the 6th week to determine if weight class and combination method affected the proportion of time spent eating, standing, drinking and lying.

Results and Discussion

Males grew faster than females during each 2-wk period in the trial, with an ADG of 880 vs. 826 gm/day over the initial 12 weeks (P<.01). Heavy pigs outperformed Medium and Light pigs during both of the first two 2-wk periods (P<.01), with 0-4 wk ADG of 794, 747 and 705 gm/day, respectively. However, differences in accumulative ADG among weight classes persisted only until week 10, and no differences existed in the 0-12 wk gains. There were no differences in ADG between grouping strategies (Uniform vs. Variable) during any 2-wk or accumulative period. The relative ADG of Heavy, Medium and Light pigs did not differ between Uniform and Variable pens. Consistent with the results for ADG, males had a greater ADFI than did females (2.52 vs. 2.25 kg/day: P<.01), but Uniform and Variable groupings did not differ (P>.10).

The emptying rates under both AI/AO and Continuous Flow Management were improved for males, compared to females (Table 1), due to their faster growth. Pigs in Uniform pens took longer to empty the room than those in Variable pens under an AI/AO management system, but the difference in average emptying time for pens under Continuous Management was reduced to non-significance (Table 2). Under the AI/AO management system advocated today, random allocation of pigs to pens, within sex, would shorten the length of a turn by more than a week. Carcass data was not affected by group or size.

Table 1. EFFECTS OF GENDER ON PEN EMPTYING RATE

	PERIOD (WEEKS)	FEMALE	SEM	MALE	SEM	PROB.
EMPTYING RATE (DAYS)	AIAO	112.30	2.248	104.00	1.851	<0.01
	CONTINUOUS	110.90	2.450	101.05	1.877	<0.01

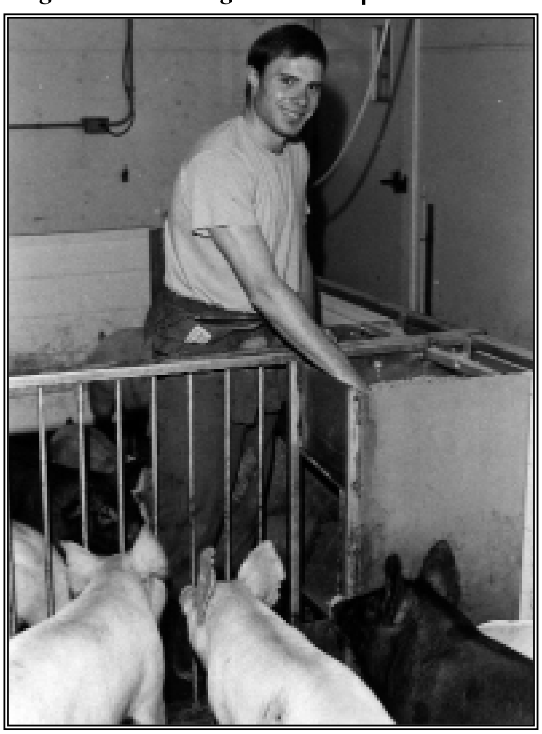
Table 2. EFFECTS OF GROUP ON PEN EMPTYING RATE

	PERIOD (WEEKS)	UNIFORM	SEM	VARIABLE	SEM	PROB
EMPTYING RATE (DAYS)	AIAO	110.88	2.133	104.06	1.955	<0.01
	CONTINUOUS	107.58	2.517	103.56	1.975	>0.10

Pig behaviour was observed and analyzed to study the effects of gender, grouping and size of the pigs on the frequency and duration of aggression. No significant differences in aggressive behaviour were found when comparing the gender, group and size differences in pigs. Behaviour was also observed to assess the effects of gender, group and size on the time budget of the pigs. The proportion of time the pigs spent eating, drinking, lying and standing were compared. There was no difference in the time budgets for size, however male pigs spent more time lying than females, the difference being made up in the time spent standing. Males spent 71.5% of their time lying while females spent 68.0%. The time spent eating and drinking were similar for both genders.

It should be noted that the pigs used in this study would be considered very uniform under most management systems until recently. The pigs were generally within 7 days of age and the weight differences were not large. The results of the study do not support the generally held assumption that sorting pigs by weight is advantageous in terms of subsequent productivity. In fact, when emptying rate is considered, it is advisable to randomly allot pigs, within gender.

Technician Colin Peterson checking single feeder in a grow-finish pen



Implications

Under the management programs of many mid- to large-sized swine farms in western Canada, with weekly weaning and grouping of pigs, there are no advantages to sorting pigs by weight as they enter the growing/finishing barn. Productivity is approximately the same in both sorted and non-sorted pigs, and behaviour responses are similar. This recommendation is particularly relevant to AI/AO systems that are becoming the standard on larger farms.

Acknowledgements

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Appreciation is expressed to Marney Korchinski who assisted with animal work, Stephanie Schmolke who assisted with observations and Kim Getson who analyzed videotapes. Appreciation is also expressed to the numerous other Prairie Swine Centre employees who helped with the project.

EVALUATION OF HUMIDITY SENSORS IN A SWINE BARN

DEVELOPMENT AND TESTING OF A PROCEDURE TO EVALUATE HUMIDITY SENSORS IN LIVESTOCK BUILDINGS

Stéphane-P. Lemay, Huiqing Guo, Ernie M. Barber and Lloyd Zyla

SUMMARY

Humidity sensors are affected by the air quality in livestock buildings. New sensor models should be tested under actual barn conditions to assess their long-term integrity. An experimental procedure was developed to meet this requirement.

After initial static and dynamic calibrations in a specially designed humidity chamber in the laboratory, the test sensors were installed in a livestock building for one year. Several times during the year, the sensors were temporarily removed from the barn and taken back to the laboratory for calibration against a reference hygrometer and determination of static and dynamic properties including accuracy, hysteresis, and time response. A bank of 72 TDK humidity sensors with different filters and coatings were evaluated with this procedure in a grower/finisher room. The drift of various static and dynamic sensor characteristics over time, the reliability, and the durability of the sensors were identified and the best sensor treatment was selected.

The results confirmed the value and practicality of the test procedure, and led to recommendations for the appropriate length of the in-barn evaluation period, calibration frequency, and required replication.

INTRODUCTION

Humidity monitoring and control have long been recognized as an important approach to improve barn environment. However, due to the corrosive and dusty environment of livestock buildings, continuous humidity monitoring has been limited by the availability of relative humidity (RH) sensors that are reliable, economical, durable, and stable. New sensors that come on the market need to be tested under real barn conditions before relying on these sensors as part of a monitoring and control system.

There is no standard procedure for calibrating or assessing the performance of RH sensors for use in livestock buildings. In this project, a procedure was developed which could form the basis for a standardized test protocol. The purpose of this report is to describe the procedure and the equipment used and to review the results of using the procedure for testing electronic sensors from one manufacturer.

EXPERIMENTAL PROCEDURE

The following criteria were identified as likely being of importance in the testing of electronic humidity sensors:

- Assessment of sensors should include static characteristics (e.g., accuracy, linearity, and hysteresis) and dynamic characteristics (e.g., time response to changing inputs).
- Testing should be performed to assess variability among multiple units of the same sensor model.
- Sensor characteristics should be assessed with clean sensors and after use in the barn for varying periods of time.
- The in-barn tests should be of long enough duration so as to fairly predict the "long-term" performance of the sensors, their durability and reliability and to assess the failure mode, whether sudden failure or a drift in accuracy.
- Air quality parameters should be monitored within the barn to assess the conditions under which the testing is done.
- Continuous recordings of the sensor output should be collected.

The test apparatus described in this report attempted to meet these design criteria. It was sized and designed for the specific application of testing a bank of 72 electronic sensors from one manufacturer but subsequent users of the protocol will be able to adjust their laboratory apparatus to suit particular needs.

Laboratory Calibrations

The main components of the laboratory test system are shown in Figures 1 and 2.
A bank of 72 electronic humidity sensors (TDK Corporation, USA) was mounted on a horizontal board (180 mm X 260 mm, Figure 3). The environ-

mental chamber into which the sensor board was placed was a shallow plastic container with a removable lid. Outputs from the sensors were directed to two networked dataloggers via three 25 pin cable connectors. Therefore, the sensors could be connected and disconnected easily from the datalogger and moved back and forth between the laboratory chamber and the barn without disturbing the sensors. No maintenance was applied to the sensors during the whole procedure.

The reference relative humidity was calculated from the dew-point and dry bulb temperatures of the air leaving the environmental chamber. A chilled mirror dew-point hygrometer and a digital platinum resistance thermometer were used in the laboratory test system.

Air flow to the chamber was provided by an air compressor. The air stream was split, one portion was passed through a desiccant drier and the other portion was bubbled through three water vials in series. A manual valve regulated the ratio of air passing through each branch. It was possible to achieve a steady flow of air at a constant relative humidity between 5 and 85% for an ambient temperature varying between 20 to 25°C.

For static calibrations, as shown in Figure 2 a), the sensors were calibrated as a set rather than one at a time. Calibration trials began with air at a relative humidity of 15%. Data were collected for 10% RH increments up to a high relative humidity of 85%. To check for hysteresis effects, the relative humidity levels were then lowered in 10% increments from 85% back to 15%. By this procedure, a total of 15 relative humidity setpoints are included in each calibration.

The same apparatus was used with modifications to determine the sensor time response (Figure 2 b)). For transient response tests, a small syringe tube (18 mm in diameter and 80 mm high) was substituted for the larger chamber and was placed over each individual sensor without removing the sensors from the mounting board. The sensors were calibrated one at a time. The conditioned air entered the top of the chamber via a tube and left the chamber at the bottom. The sensor was first stabilized with dry air for 2 min, then the pinch clamps were adjusted to let the moist air enter the chamber. The sensor output was recorded at 1 s intervals for 2 min or until the sensor stabilized at the new output. The pinch clamps were then adjusted again to introduce dry air back into the chamber and the monitoring continued until a new equilibrium was reached. This procedure was repeated three times for each sensor.

In-barn evaluation of sensors and environmental monitoring

After the initial calibration, the sensors, still on the mounting board, were installed in a grower/finisher room (14.4 m X 11.2 m, 144 pigs) at 1.5 m above the floor (Figure 4). The outputs of the sensors were collected every 15 min with the hourly average recorded by the datalogger. Environmental variables including room temperature, dust mass concentration, ammonia, carbon dioxide and hydrogen sulfide concentrations were measured simultaneously.

Analysis of sensor characteristics

The accuracy of the sensors was assessed by the mean errors of the sensors at the 15 humidity set points, i.e. over 15 to 85% RH, as compared with the reference hygrometer readings for each static calibration. The maximum errors were also provided for further information.

Settling time and time constant were used to evaluate the dynamic properties of humidity sensors. Settling time is the time required by the sensors to reach 95% of the total difference of the step input.

RESULTS AND DISCUSSION

Seventy two TDK electronic humidity sensors were evaluated at PSCI from October 1996 to November 1997 using the described procedure. During the in-barn evaluation period, sensors were taken back to the laboratory for intermediate calibrations on a monthly basis. A total of 12 static calibrations and 2 dynamic calibrations were completed.

Sensor treatments

Two types of sensors were used in the study: CHS-UGS and CHS-GSS sensors. The stated accuracy is ±5% and the guaranteed operating range is 5 to 95% for CHS-UGS sensors and 5 to 90% for CHS-GSS sensors.

The experiment involved uncoated sensors compared to coated sensors, and a comparison of six different filtration treatments, all intended to protect the sensors from the barn environment. The coating treatment involved a pure silicone conformal coating on the electronic portion of the sensors and a spray coating of silicone to the pin and socket connections after the sensors were installed. Filter 1 was the unfiltered treatment consisting of the standard packing material. Filters 2 to 6 were proprietary compositions developed by the manufacturer of the sensors.

The factorial experimental design included two sensor types, two coatings, and six filter treatments for a total of 24 treatments. Three replicates were involved for a total of 72 test sensors. Treatments 1 to 6 refer to CHS-UGS sensors with coating and filters 1 to 6, while treatments 7 to 12 are uncoated CHS-UGS sensors with filters 1 to 6, respectively. Treatments 13 to 18 are CHS-GSS sensors with coating and filters 1 to 6, and treatments 19 to 24 are uncoated CHS-GSS sensors with filters 1 to 6, respectively.

Environmental conditions in the barn

The environment observed in the experimental room over the year was typical of swine barns. The relative humidity varied from a low of 22% to a high of 99% with a yearly average of 63%. The temperature varied over a wide range from 11.4 to 30.0°C with a yearly average of 18.0°C. The carbon dioxide concentration was between 500 to 4,000 ppm and the yearly average was 1,928 ppm. Ammonia concentration in the air ranged from 8 ppm in summer to higher than 20 ppm (maximum detectable concentration) in winter. Hydrogen sulfide was not detected for the first five months at a detection level of 0.3 ppm, so it was not measured for the rest of the experiment. The dust mass concentration ranged from 0.35 to 2.51 mg/m^3 with a yearly average of 1.22 mg/m^3. Whereas the air quality in the room was normal for pig buildings, the contamination level constituted challenging conditions for electronic humidity sensors.

Sensor accuracy drifts

Table 1 shows the mean and maximum errors of each treatment for CHS-UGS sensors at the initial, middle and final calibrations. The change in mean error for all 24 treatments is shown in Figure 5.

At the initial calibration, the average mean error of the CHS-UGS sensors in each treatment ranged from 1.9 to 4.6% (average: 3.4%), while the error ranged from 2.4 to 5.3% (average: 3.8%) for CHS-GSS sensors. The sensors were within or close to their stated nominal accuracy of ±5% prior to installation in the barn. There was no statistical difference among all treatment combinations at this time ($P>0.05$).

The error of all sensors increased gradually over time, which indicated that the barn environment had significant influence on the sensors. Over the one year in-barn exposure, all the CHS-GSS sensors failed within 1 to 5 months. Three of the CHS-UGS sensors also failed. In the final calibration, the mean errors of CHS-UGS sensors varied from 8.0% (treatment 6) to 26.5% (treatment 5). There was no significant difference among coating and filter treatments. However, significant differences existed among the combined effects of coating and filtering treatments. Treatment 6 had a significantly lower error than nine of the other treatments ($P<0.05$).

To better compare the drift in sensor accuracy, calibration data are shown for two sensors from the initial, middle and final calibrations (Figure 6). For each sensor, data are given for both the rising and the falling RH calibrations. It is clear that the test procedure was able to distinguish between the two different sensor performances and sensor treatment 6 was identified as the best treatment.

Sensor time response properties

Table 2 shows initial and final time response results for CHS-UGS sensors. All the sensors responded to a falling humidity input much faster than to a rising humidity input. The time response of the sensors for a falling humidity input was quite stable after one year but it became much slower in the rising process. Treatment 6 sensors were significantly faster than eight of the other treatments ($P<0.05$).

Discussion of the experimental procedure

The experience gained in this project demonstrated the necessity for testing new models of humidity sensors under both laboratory and barn conditions. The initial laboratory calibration results for all 72 sensors were satisfactory and the CHS-GSS sensors did not show any difference compared to CHS-UGS sensors. However, after their barn exposure, all of sensors demonstrated increased errors and the two types of sensors demonstrated markedly different performance. Testing sensors only in the laboratory would fail to distinguish among alternative sensors with quite different in-barn performances.

The laboratory calibration setup and procedures are practical and adequate to evaluate various static and dynamic characteristics of humidity sensors. By keeping the reference hygrometer in laboratory, its accuracy can be maintained and the sensor calibration results can be assured. Although the time response calibration method may not provide a true humidity step change, it provided enough data to describes the sensor time constant and settling time with sufficient sensibility to quantify the impact of barn exposure on sensors. The best treatment among 24 treatments was selected as treatment 6 (coated and with filter 6).

In terms of the in-barn evaluation time, one year appears to be the minimum period to evaluate humidity sensors. A four-month period was enough to identify sensors that were particularly sensitive to the barn environment, e.g. the CHS-GSS sensors, to see failure due to excessive errors or complete failure. However, some sensors performed well for up to 9 months and then demonstrated unacceptable errors. Figure 5 suggests that the error for some sensors was still increasing. Hence, one year is recommended as a minimum evaluation period.

The tested sensor accuracy drift was successfully monitored with monthly calibration. However, since the sensor error increased rapidly in the early stage of the in-barn exposure, a more economical procedure may be to conduct the first two intermediate calibrations once every two weeks, then once a month until six-months, then every two or three months thereafter.

A reliable evaluation of humidity sensors requires that a minimum of three sensors of one type be tested. This project demonstrated that there is sufficient variability among sensors of the same type to cast doubt on the reliability of results from the testing of only one sensor.

IMPLICATIONS

The RH sensor evaluation procedure combining sensor laboratory calibration and in-barn exposure proved to be effective and practical for assessment of RH sensor performance in livestock buildings. This procedure is applicable for selecting RH sensors for long term relative humidity monitoring and control in swine barns.

The RH sensor accuracy will be modified in various ways when it is exposed to barn conditions. Only a regular monitoring of the sensor accuracy will ensure a proper humidity control within the building.

One unit of a sensor model cannot be used to characterize many sensors of the same type. All sensors used in a barn have to be calibrated independently.

ACKNOWLEDGMENTS

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The pork producers of Saskatchewan, Manitoba, and Alberta are acknowledged for their strategic support of the Prairie Swine Centre Inc.

Figure 1. **Schematic diagram of the static calibration equipment**

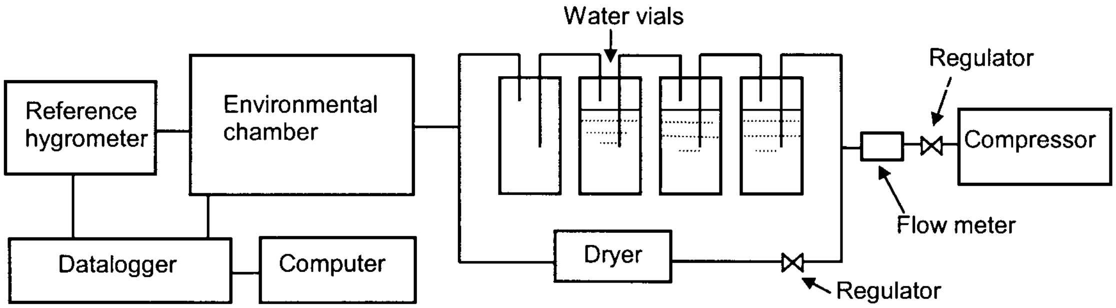

Figure 2. **Sectional sketches of environmental chambers**

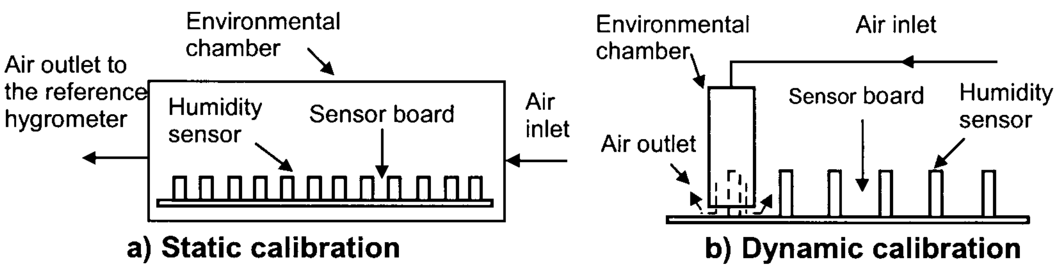

Figure 3. **Sensor arrangement on the electronic board**

Figure 4. **In-barn sensor installation setup**

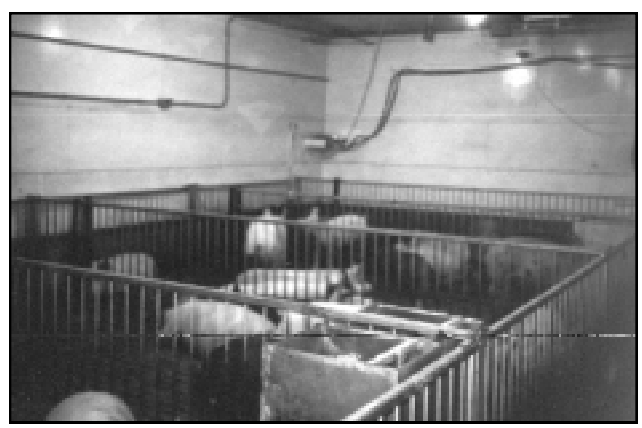

Figure 5. Accuracy drift of CHS-UGS and CHS-GSS sensors over the year

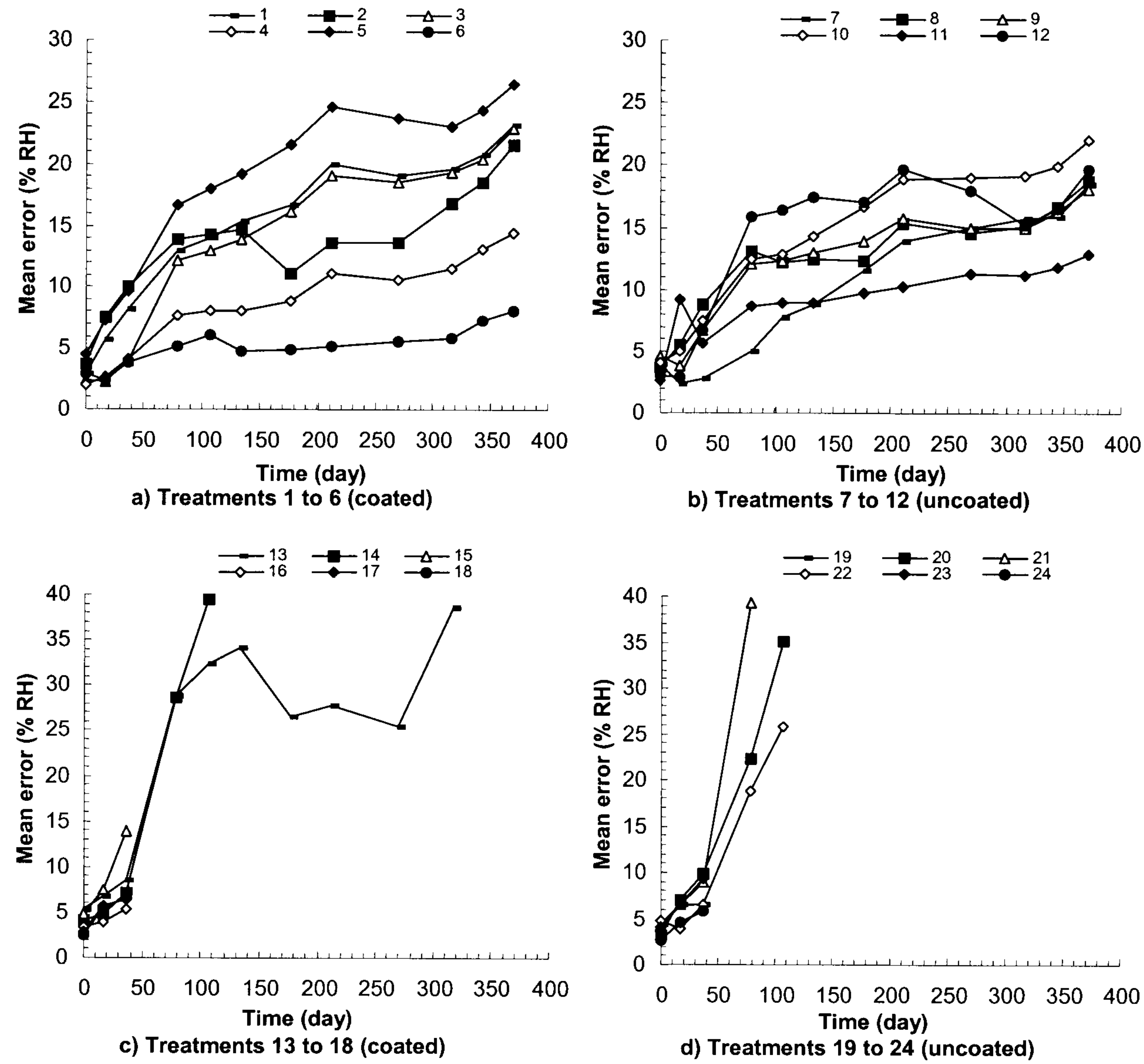

Figure 6. Accuracy drift of two sensors over the experimental year

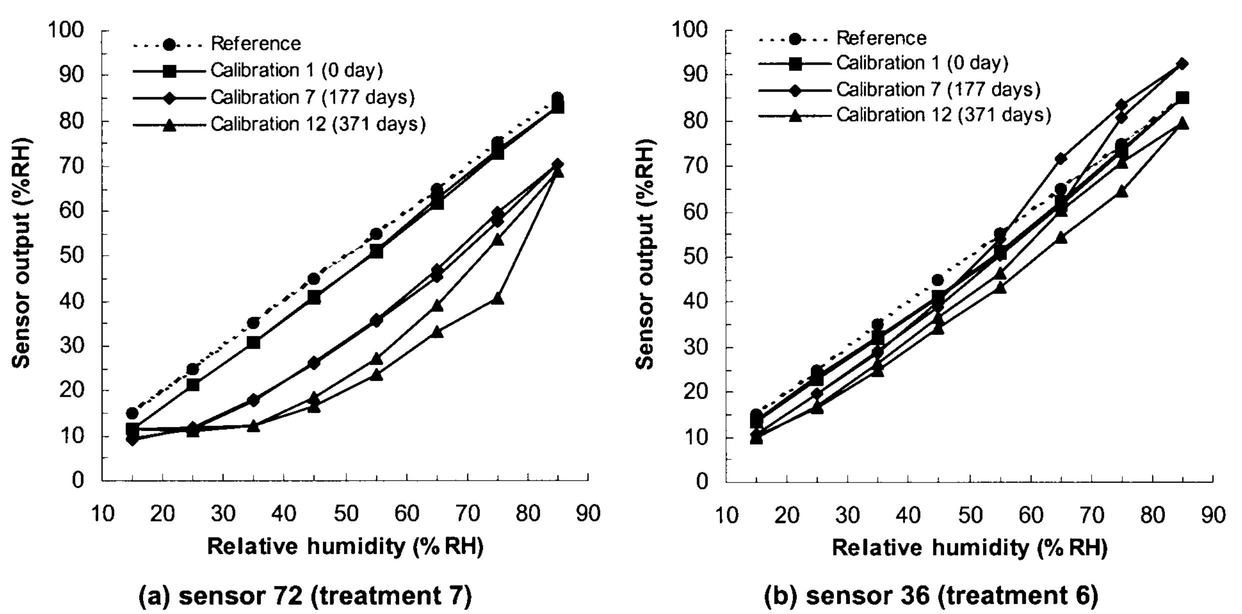

Table 1. Mean and maximum errors for TDK CHS-UGS sensors

Time (Day)	Error (%RH)	Treatment 1	2	3	4	5	6	7	8	9	10	11	12
0	Mean	2.9	3.7	2.4	1.9	4.4	2.9	4.0	3.7	4.6	4.1	2.7	3.0
	(SD)	(1.1)	(2.0)	(1.2)	(1.0)	(1.7)	(1.4)	(1.6)	(1.8)	(1.8)	(1.6)	(0.9)	(1.4)
	Max.	4.4	6.5	4.3	3.5	6.6	4.9	5.7	6.1	6.8	6.3	3.9	4.9
177	Mean	16.6	11.1[1]	16.1	8.8	21.5	4.9	11.5	12.4	13.9	16.7	9.7	17.0[1]
	(SD)	(6.5)	(3.5)	(6.0)	(3.3)	(7.4)	(1.6)	(4.4)	(5.0)	(5.8)	(6.0)	(3.7)	(7.5)
	Max.	22.8	15.2	21.8	12.5	28.7	7.4	15.6	18.0	21.0	22.2	13.9	24.2
371	Mean	23.1	21.5	22.8	14.5	26.5	8.0	18.5	18.7	18.1	22.0	12.8	19.6[2]
	S. A. [3]	ab	abc	abc	Bcd	a	d	abc	abc	abc	abc	d	abc
	(SD)	(11.0)	(7.7)	(9.6)	(5.2)	(11.6)	(3.0)	(9.1)	(6.8)	(8.7)	(10.4)	(6.1)	(10.3)
	Max.	35.2	29.0	34.1	20.7	39.8	12.1	29.1	26.0	28.0	33.8	20.2	31.7
	S. A.[3]	ab	abc	abc	bcd	a	d	abc	abcd	Abc	abc	cd	Abc
Average		14.8	13.3	13.7	8.5	18.2	5.2	10.7	12.4	12.2	14.3	9.2	15.3

[1] The data from this calibration are average errors of two sensors since one sensor failed.
[2] The data from this calibration are errors of the only sensor left, the other two sensors had failed.
[3] S. A.: statistical analysis. Means or maximums within a line characterised by the same letter are not significantly different (P<0.05).

Table 2. Time response calibrations for TDK CHS-UGS sensors

Calibration	Treatment No.	Sensor output (%) Rising[1] Initial[2]	Rising[1] Final[2]	Falling[1] Initial	Falling[1] Final	Time constant (s) Rising[4]	Time constant (s) Falling	Settling time (s) Rising	Settling time (s) Falling
Initial	1	8	87	88	7	10.0	4.5	30	13
	2	6	66	67	6	14.5	3.4	44	10
	3	6	76	76	6	7.3	1.7	22	5
	4	6	73	73	6	14.3	4.2	43	11
	5	6	69	69	7	11.7	2.2	35	5
	6	6	73	73	6	7.8	1.5	23	4
Final	1	10	46	50	10	31.9ab	4.2	97	11
	2[3]	7	49	53	8	33.2ab	6.7	95	20
	3	8	52	54	8	32.2ab	5.0	98	13
	4	8	55	56	8	30.0bcd	5.1	90	15
	5	8	31	32	8	33.3a	3.0	100	8
	6	8	72	75	7	26.9d	4.8	81	15

[1] Rising or falling process.
[2] Initial or final value.
[3] Two sensors left and one sensor failed.
[4] Values in this column for final calibration followed by the same letter are not significantly different (P>0.05).

BARN MANAGEMENT AND CONTROL OF ODOURS

BARN MANAGEMENT AND CONTROL OF ODOURS

Stéphane P. Lemay

P.O. Box 21057, 2105 8th Street East, Saskatoon, SK, Canada, S7H 5N9, E-mail: Lemay@sask.usask.ca

INTRODUCTION

Odour emissions from swine facilities are one of the most important concerns raised by municipalities and the general public regarding the pig industry. An adequate odour control strategy is a key component to establish and maintain good relationships within a new community or an existing neighbourhood.

Odour emanating from the ventilation system of a hog barn, as well as odour produced from manure storage and handling, is a significant contributor to the total farm odour emissions. In Bundy (1997), figures are presented on the justifiable complaints associated with different odour sources in swine production. Buildings were the source of 22% of the total odour complaints; slurry storage was accountable for 17%; slurry spreading for 52%; animal feed production for 8% and silage clamps for 1%.

Dr. Lemay explaining the use of an inflated cover to control odours emanating from a concrete manure storage

Odour emissions from storage facilities can be controlled by the use of covers. Different types of concepts have been tested to cover manure storage facilities and reduce odour emissions: organic material (corn stalks/cobs, straw, rice hulls, peat moss), inorganic material (leka rock, oil layer), solid roofs and inflatable covers. Although many experiments have been conducted in pilot-scale tanks, some of the testing has also been done on commercial scale manure storage tanks or lagoons. Organic material such as wheat straw or corn stalks showed an important odour reduction on pilot-scale storage facilities (Bundy et al., 1997). The Prairie Agricultural Machinery Institute (PAMI) has also demonstrated that applying barley straw on manure lagoons can substantially decrease odour emissions. Prairie Swine Centre Inc. (PSCI) operates an inflatable cover for a concrete manure tank on a continuous basis. Research results indicated that this inflatable structure was efficient in reducing gas emissions from the tank.

Different manure spreading techniques have been used to lower odour emissions. Deep injection and shallow injection reduce odour emissions compared to not injecting but requires more energy and larger tractors than surface application. Spreading equipment using dribble bar and curtain techniques that apply the manure close to the ground surface also reduce odour emissions. All techniques that limit the vaporization of manure in the air and that apply it closer to the ground will provide some odour control. Therefore, different alternatives have already been identified to reduce odour emissions from storage facilities and from manure spreading.

The odour nuisance definition implicitly embodies one or more of the following quantifiable characteristics of odour: 1) frequency; 2) intensity or concentration; 3) duration; and 4) offensiveness. For example, manure spreading is an operation that often produces an intense and offensive odour. However, its level of nuisance can be reduced by spreading the manure only once a year (low frequency) and with proper equipment that allows completing the work in a short period of time (low duration).

By its continuous operation, building odour emissions constitute a nuisance with a high frequency, duration and offensiveness. For this reason, the goal of the following discussion will mainly be to focus on building odour emissions and ways of controlling it.

BUILDING ODOUR: NATURE AND SOURCES

The sense of smell plays an important role in the human sensation of comfort. Since it is an individual character, some people will have a very sensitive nose as others will have less sensitive sniffing capabilities. Because the human nose synthesizes the odour characterization of a complex gas mixture rather than analyzing each chemical compound individually, it is still the most accurate measuring device for odour measurements.

Odour in swine production is the result of a mix of various chemical substances. Those substances contribute to the odour intensity and offensiveness depending on their own odour character and concentration. Over 165 volatile compounds have been reported so far in an air sample coming from a swine facility (Miner, 1995). Most of those odorous substances can be classified into different classes of chemical compounds such as the volatile fatty acids (ex.: acetic, propionic, butyric acids), phenols, nitrogen derivatives (such as ammonia, amines, indole, skatole) and reduced sulfur compounds (for example: thiols, sulfides, disulfides, thiophenes). Those chemical compounds come mainly from the degradation of the plant fibre and protein in the diet, and also from the anaerobic degradation of other more complex chemical compounds.

Within the building, odours come from the feed and feeding facilities, the pigs themselves, the floor and others surfaces (pens or building) and the manure produced by the animals. All those sources will contribute to the odour coming out of the ventilation system. As said previously, outside the building, odours will come from manure storage facilities (tanks or lagoons), from manure spreading and also from dead animal disposal.

ODOUR DETECTION TECHNIQUES

Odour evaluation is an important aspect to be considered as the choice between abatement techniques, novel building designs and management practices rely on the change in odour concentration and offensiveness. Odour evaluation has been developed over the years and four techniques based on sensory odour analysis (human evaluation) are available: ranking, rating, magnitude evaluation, and forced choice dilution (Riskowski et al., 1991).
The ranking method consists of the evaluation of pairs of samples to determine the more offensive one and to place those samples in sequential order. This method is quite precise for the ranking of samples; however the differences between those samples cannot be evaluated. When using the rating method, the panelists, using a scale (generally from 0, being no odour or not offensive, to 10, being very strong or very offensive) have to assign a number to a sample. The magnitude estimation is quite similar to the ranking method with the difference that panel members are given reference points that can be used throughout the odour analysis to help evaluate the scale magnitude.

The dilution method using a dynamic forced choice olfactometer is the most recognized technique to measure odour concentration. It is used internationally and standard procedures have been developed over the years. The dynamic dilution method consists of the dilution of odorous samples with odourless air. The panelist is offered different air samples (generally three). Two air samples do not contain any odour and the third one is the odorous compound with a really high dilution ratio. The dilution ratio needs to be high enough to ensure that panelists are not able to detect the odorous sample. The dilution ratio is subsequently reduced until the panelist can detect the odorous sample twice in sequence. Eight panelists are normally required for each air sample. The odour threshold or concentration corresponds to the air dilution ratio (odourless air volume/odorous air volume) where 50% of the panelists are able to detect which port is the odorous air. For most of the dilution tests, odorous samples are taken on site and put in Tedlar bags. The analysis is then completed by panel members in the laboratory.

Some scientists have used cotton swatches to collect odour. However, a comparison study between the swatch technique and odorous samples directly taken on site showed that the swatch technique did not give reliable results for moderate to high odour concentration (Nicolai et al., 1997). In all cases using odour samples, the analysis must be done in a relatively short time period (within 48 hours from the time of collection) to prevent chemical reactions between the odorous components.

To obtain complete information on a specific odour, its intensity and hedonic tone also have to be evaluated. Two different air samples can have the same odour concentration but quite a different pleasantness (ex: food smell and pig manure smell). Odour intensity characterizes an impression of odour offensiveness represented on an intensity scale. Another method that can be used to evaluate odour intensity is by comparing it to a reference odorant (1-butanol (C_4H_9OH)) presented to the panelist at various concentrations (Miner, 1995). Odour intensity can then be represented as a number from the scale or in term of 1-butanol concentration. The hedonic tone is more the qualification of the odour on a scale from extremely unpleasant to extremely pleasant (ex: -4 to +4). For these evaluations, odour samples are not diluted and the olfactometer is used to present the samples to the panel.

Electronic noses have also been developed to evaluate odour level. However, this technology has yet to be improved for complex odour mixes coming from many chemical components. This technique would present interesting advantages as odour analysis could be done directly on site without a panel.

Because odour is a mix of chemical components, it must be treated as a whole when dealt with. Some attempts have been made to identify specific chemical components such as ammonia, hydrogen sulfide and fatty acids that are relatively easy to measure and which could be used as odour indicators. However, research linking chemical levels to odour levels has been inconclusive and no general correlation can be used to relate specific chemical concentration to odour levels.

BARN ODOUR CONTROL

Cleanliness and Building Design

Maintaining cleanliness of animals, floors, pens and building surfaces is a way to lower odour emissions. The soiling of surfaces with manure within the building increases the air/manure contact area and thus increases odour emission rates. Any steps (such as frequent manure removal) that prevent anaerobic degradation of the manure within the building will lower odour emissions. From a practical point of

Clean pens and pigs contribute to lower odour emissions

view, it means that when a room contains dirty pens, pen scraping would reduce odour concentrations within the room and its total emission into the environment. Attention should be given to improper air distribution or drafts that would modify the dunging area, especially for barns with partially slatted floors.

For new buildings, considerations can be made to specific designs that would lower emissions: flushing gutters, limited surface gutters, or solid manure management systems. Although manure composting and deep litter systems for pig buildings have been studied, they are only applicable in particular conditions (restricted land base area for manure spreading, long transportation distances, availability of carbon sources), and more research or feasibility studies are required to apply those techniques on a large-scale basis.

Many low emissions systems have been developed and studied in Europe (ex: limited surface gutters). However, those systems would probably have to be adapted to North American conditions before being broadly implemented.

Scientists at PSCI will contribute to the evaluation of an innovative building design recently suggested by Dr. John Feddes at the University of Alberta. The proposal is to modify the configuration of the swine building to confine manure storage within the building, thus insulating the pig dunging airspace from the pig/worker airspace. When manure storage is confined within the building, traditional odour sources (building and storage facilities) are reduced to only one source: the building. In this unique example, the grower-finisher barn design will be modified to create two independent airspaces, each with an independent ventilation system. In this way, odour and gas emissions from the manure and the dunging area will be confined to this airspace and will not escape into the worker area. The exhaust air from the dunging area will be directed through a biofilter prior to being discharged into the outdoor environment. This building design is expected to reduce total odour emissions from the building and from the manure storage area improving indoor air quality for the worker. This project is conducted in collaboration with Dr. Ernie Barber at the University of Saskatchewan and Richard Coleman at the Alberta Research Council. The project conclusions will be available in fall 2000.

Dust and Odour

Dust particles found in swine buildings act as important odour carriers. Dr. Steve Hoff at Iowa State University initiated a laboratory experiment in 1997 where dust particles were removed from a swine building air sample to provide evidence of the role of dust in carrying livestock generated odours. Odour threshold was reduced for all experiments, ranging from a low of 23 % to a high of 76% for a dust particle count reduction of 47 to 98%. It meant that removing particles from ventilation air can effectively result in a substantial reduction in odour. Following this preliminary study, full-scale measurements showed odour threshold reductions of 50 to 90% between the inlet and outlet of the filter when dust removal varied between 45 to 75%.

Consequently, dust particles emitted from the building ventilation system are responsible for a large portion of building odour emissions. If the dust concentration is reduced within the building, it will also be decreased at the fan level and consequently, total building odour emissions will also be reduced.

In a pig barn, dust is generated from the feed, bedding, dried manure, skin and building materials. Daily operations can have an impact on feed, bedding and dried manure. To reduce dust, regular cleaning and maintenance is required. Air circulation over dusty surfaces will return dust particles back into the air flow which will increase dust concentration. It is therefore important to periodically clean the room. Feed spillage from the feeding system or feeders must be minimized in order to reduce dust production from the feed.

In terms of the dust removal efficiency, oil/water spraying is one of the most efficient dust control techniques for livestock buildings. Two Danish systems have been developed over the last ten years and they use a mixture of water and rapeseed oil to control the dust. From long-term observations done in different sections of a pig barn, those systems reduce respirable dust levels by 52 to 76%.

Previous work at PSCI demonstrated that sprinkling a small quantity of pure canola oil on the floor of animal buildings reduced respirable and inhalable dust by 71 and 76%, respectively. In a complementary study, a 27 and 30% reduction of hydrogen sulfide and ammonia concentrations were observed with canola oil sprinkling. The oil film presumably reduced emission rates of gases into the air, but mechanical and chemical reasons for the gas reduction need to be investigated.
A research project will be initiated at PSCI to determine the interaction of different canola oil application rates and experimental diets on odour, dust and gas emissions from swine buildings. This research involving scientists from three Canadian provinces (Alberta, Québec, Saskatchewan) will quantify the real impact of a combined engineering and nutrition strategy to reduce odour and gas emissions from pig barns.

Dietary Manipulation, Feed and Slurry Additives

Reduction in crude protein content of the diet with adjustment to maintain essential amino acid levels results in a reduction of the nitrogen excreted by the pig. Results from different experiments show that this reduction in excreted nitrogen leads to a reduction in the concentration of selected odorous compounds (volatile fatty acids, phenols, indole). Until now, it appears that the cost of synthetic amino acids is the main factor limiting the utilization of these diet formulations by the industry.

Many companies produce additives for use in livestock feed and manure and claim that they offer substantial benefits to producers. These benefits include reduction in odour, nutrient loss and pit gas production, and a breakdown of solids. Most of those products are clay minerals (bentonite), powdered rock (zeolite), algae, plant components (yucca extracts), bacterial and enzyme cultures, microbe nutrients and chemical products (acids). Depending on their nature, these products can be added to the feed, the manure channels or both (feed and manure). Many experiments on additives have not reported significant odour reductions. In some cases, reductions in concentration of specific chemical compounds (ammonia, hydrogen sulfide, volatile fatty acids) were measured (Barrington and Mouebbed 1995; Airoldi et al. 1993) but no direct conclusions on odour can be drawn as no direct odour measurements were taken.

Additive testing done in Minnesota (AURI, 1997) showed various levels of odour reduction in tests on eight products that cost less than 0.95 CAN$ per marketed pig. The olfactometry technique was used to measure the effect of each products compared to an equivalent control barn. However, the protocol did not include any replication and the odour level of control barns varied widely.

Some problems arise from additive testing as procedures often differ from one lab to another and the results can hardly be compared. Also, it is difficult to assume that the products will show the same results under laboratory conditions as they would in commercial scale conditions.

Three different kinds of pit additive are being tested at PSCI in full-scale manure channels. The main goal of the study is to measure physical and chemical characteristics, and evaluate odour and gas emissions from swine manure treated with three different manure pit additives, in full-scale channels and during a one month storage period. Because the testing is completed in normal barn conditions (full-scale room and channels, continuous manure addition by the pigs), this project will provide factual information regarding the performance of pit additives for odour and solid control. The project should be completed during the winter 2000.

Testing Manure additives. In this design each channel under the slat is used to compare various additives under similar conditions and within the same room

Biofilters and Bioscrubbers

Different techniques have been used to control odour as the air comes out of the building. Biofilters and bioscrubbers or wetscrubbers are some of those technologies used to treat exhaust air from livestock buildings.

With a biofilter, the exhaust air is de-dusted and pushed through an organic material (compost, peat moss, straw or crop residues, wood bark). This bedding material must be humidified and inoculated with a bacterial population. As the exhaust air comes in contact with the bedding material, the bacteria breakdown odorous and chemical compounds present in the air.

Research has included testing on pilot-scale and full-scale biofilters. Three pilot-scale biofilters made of a 3:1 mixture of yard waste compost with wood chips (by volume) were tested at North Carolina State University. The odour reduction measured by intensity, irritation intensity, and unpleasantness for five tests equalled 61, 58 and 84%, respectively.

Low cost biofilters are currently used in Germany on many farms (Zeisig and Munchen 1988; Hartung et al. 1997). The one developed and tested by Nicolai and Janni (1997) is showing interesting performance with odour concentration reductions in the range of 75%. Operation and construction costs of such biofilters have been evaluated at 0.40 CAN$ per piglet produced for a 700 sows farrowing facility.

Lais et al. (1997) present results obtained with a bioscrubber provided with a water base. In a bioscrubber, the exhaust air is washed with a recycled liquid (water is often used). In all cases as the air is cleaned, the liquid that is being recirculated in a closed circuit becomes charged with different chemicals or airborne particles. After a certain operating time, this sludge has to be changed and disposed of properly. Odour reduction can vary between 60 and 90%; however the cost of such technology is very high, ranging from 12.75 to 24.15 CAN$ per market hog.

A combination of biofilter/wetscrubber has also been tested and no real conclusion could be drawn on odour reduction (Siemers and Van den Weghe, 1997). The air coming out had a different odour but was as strong as the one coming in for treatment. The cost associated with the combination of such techniques is 6.10 to 6.75 CAN $ per market hog.

Biofiltration technology appears to have a lot of potential to control odour and gas emissions from livestock buildings. Although there is no biofilter ready for the marketplace, research results suggest that the technology will probably be feasible under real commercial conditions. Biofilter efficiency depends on the type of bacteria, air and bedding temperatures, bedding moisture level, air flow rate, pressure drop through the bedding material, etc. The main limitation of biofilters for livestock buildings is the bedding size required to treat the large air flow rate out of the barn ventilation system with a short retention time.

Until now, bioscrubbers and wetscrubbers seem to constitute a very expensive technology to install and to operate. Moreover, the out coming sludge has to be adequately managed to not create another environmental problem.

Site Selection and Management

For new swine housing projects, the choice of a site has to be done in a way to limit nuisance odours. A study of local conditions such as the prevailing winds and distances from the closest neighbours, have to be done. Proper separation distances from neighbour residents generally allow for sufficient odour dilution.

A proper windbreak acts in two ways to reduce odour emissions from a production site. First, it slows down the air speed of predominant winds. In this case, the odorous air has more time to be diluted before reaching a specific distance from the site. Secondly, it increases the dilution rate of odorous compounds in the ambient air by creating more turbulence in the global airflow. Rows of threes are probably the most effective way of building such a windbreak in an esthetical and sustainable manner.

SUMMARY

Building odour emissions constitute an important contributor to the level of nuisance caused by a pig farm. Those emissions are less intense than what is produced by manure spreading, but their frequency and duration are much higher.

The nature and concentration of more than 160 compounds affect odour characteristics of an air sample collected in a swine building. Considering this complex mix of substances, the human nose is still the best instrument to characterize odours. The forced choice dynamic olfactometry method is the most accepted technique used to measure odour concentration and intensity. It requires a meticulous selection of panel members, expensive equipment and an experienced panel leader.

Different techniques have been discussed to reduce odour emissions from swine buildings. Even if a lot of research has been done, many questions stay unanswered. For example, more information is required on performance and impact on odour before new building designs, feed and slurry additives and biofilters can be recommended and applied on a large-scale basis. However, if the barn is kept very clean, the manure is removed as often as possible, an efficient dust control technique is implemented and multiphase feeding programs are used (to reduce nitrogen excretions), odour emissions from the building are likely to be maintained at an acceptable level for the average farm community.

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