1995 ANNUAL

PRAIRIE SWINE CENTRE INC.

The Prairie Swine Centre is pleased to present our 1995 Annual Research Report

HIGHLIGHTS

Highlights of the 1995 Research Report:

- Spray-dried blood cells and lactose are an effective and economical replacement for whey in early wean diets (p.26).
- Formulating finishing diets without vitamins and trace minerals can reduce feed costs without affecting performance (p.29).
- Weaned piglets show a preference for three different methionine supplements (p.32).
- Feeder position and orientation in the pen affects pig behaviour (p. 37).
- Stereotypies in dry sows signal an inadequacy in the environment, inadequate energy intake is implicated (p.42).
- Using particle separation theory to develop a uniflow aerodynamic deduster prototype (p. 46).
- Oil sprinkling reduces barn dust concentrations by 80% (p. 51).
- Survey data combined with computer simulation program helps to determine optimum marketing scheme (p. 56).
- Sorting grower-finisher pigs into pens according to body weight is more effective at the time they enter the barn then at 75 kg. (p.59).
- The physiological and social stresses of weaning are demonstrated with new test (61).
- *Strep. suis* vaccine shows promise for reducing piglet mortality (p. 63).
- Ventilation system design can be studied using modelling techniques to support in-barn research (p. 66).
- Animal handling is an economic issue as well as one of animal wellbeing (p. 72).

"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

The Prairie Swine Centre focuses on issues of efficiency and sustainability. While much of the research program seeks to improve the individual pork producer's net income, through nutrition, management and housing, there is also a need to deal with issues that have less direct economic impact but clearly influence the future success of our industry. Currently, the issues of animal welfare and human health are two important focuses of the Centre's research, technology transfer and teaching programs.

Funding

The Centre must attract funding in order to survive. This is one of the corporation's strengths.
It ensures that the Centre is responsive to industry needs and input. This is clearly demonstrated by the make-up of its Board of Directors. In addition, the Centre was established with a view to attracting funds from a wide variety of sources; this reduces dependency on any one source and at the same time reduces the cost to any one participant in the Centre's various programs. About one-third of total revenues are derived from sale of stock; this encourages the Centre to be a good pork producer, which many producers tell us is critical to our being a good research facility. The subject of funding is covered in greater detail in the President's Report.

Staffing

The strength of any organization is its staff. While the Centre is proud of its modern, practical research facilities, its greatest resource is its people. There are a total of 38 people currently employed by the Centre in a variety of professional and support positions.

Graduate Studies

Graduate students bring a new perspective to the Centre. Their intense interest often leads to new questions being asked and traditional ideas being challenged. The Centre currently has three graduate students - two in ethology and one in engineering. Further expansion of graduate training is expected in the future.

Facilities

The Prairie Swine Centre is the largest swine production research facility in Canada. With more than 77,000 ft^2 of barn and office space, it maintains a unique array of research capability on one site.

Original Facilities

The original 250 sow farrow-to-wean unit was built in 1980 by the University of Saskatchewan. It consists of two 100-sow and one 50-sow units, each with its own gestation, farrowing and weanling areas. A small feeder barn was also built at that time consisting of 24 pens capable of holding 10 pigs each.

Grower-Finisher Research Unit

In May, 1992, pigs were first introduced into the new Grower-Finisher Research Unit. This unique facility was designed by a commercial engineer and constructed using the same materials and methods employed by the commercial pig industry. The cost of the new unit, at about $35/$ft^2$, is only moderately higher than the $20 to $25/$ft^2$ experienced by commercial units. Yet, this includes a wide array of specialized research equipment and facilities; this cost also includes office facilities for the expanded research staff. The unit can be divided into 5 functional areas: basic, intensive, semi-intensive, commercial and proprietary.

Basic

The basic research area includes a fully-equipped surgery, related prep areas, two small experimental rooms designed for flexible research use, and a very sizable metabolism room that can accommodate up to 20 metabolism crates for large-scale digestibility studies.

Intensive

The intensive research area includes two rooms of 76 individual pens each. These rooms are designed for use in experiments where individual animals are the focus of research or where only small quantities of test materials are available for nutrition experiments. The pens are designed to be modified, to convert from one pig in a pen up to 5 pigs in a pen, depending on the needs of the experiment.

Semi-intensive

Oftentimes, research requires facilities that are midway between commercial scale and intensive. The semi-intensive rooms were designed to fulfill this need. Four rooms each contain 20 pens designed for 5 pigs each. Again, the penning is flexible, allowing groupings larger than 5 pigs when desired.

Commercial

The commercial area actually includes two types of facilities. In one area, there are three rooms of partially-slatted floor pens; each room consists of 12 pens housing 12 pigs each. Although somewhat smaller than the typical commercial group size of 20 to 30, the commercial rooms allow research to be conducted in facilities that in most respects resemble recently constructed commercial barns.

A second area of the commercial wing includes two engineering rooms. These consist of 12 pens of 12 pigs each, housed in fully-slatted floor pens. However, the rooms are designed for maximum flexibility so that they can be converted to partially-slatted or even totally-solid floors. The ventilation system can be completely changed to incorporate a wide array of options in both inlet and exhaust design.

Proprietary

The proprietary area includes 4 semi-intensive rooms and one metabolism room, similar to that in the basic area. This provides Prairie Swine Centre with unique facilities to serve the commercial sector; indeed, companies from across the United States and from as far away as Europe have contracted with the Centre to conduct research on their behalf. This not only helps the financial situation of the Centre, but places it firmly in the "big leagues" of swine research worldwide.

Other Facilities

In addition to the above, the Centre maintains an office building complete with offices for the research and administrative staff as well as graduate students. It also has a simple laboratory and reading room. By employing modern communication technology, the Centre is linked through computer networks to researchers on campus and around the world. Prairie Swine Centre Inc. employs research and support staff to ensure that all research and technology transfer objectives are met. Each member of the Executive Management Team brings a wealth of research and practical pork production experience.

BOARD OF DIRECTORS

Left to right seated; Roy Piper, John Patience, Weldon Newton, Harold Fast, Bill Devereux
Left to right standing; Terry Scott, Florian Possberg, Mac Sheppard, George Lee, John Stewart.

Board of Directors:

The Centre's Board of Directors has 10 members as of June 30, 1995. They represent the diverse interests of the western Canadian swine industry, including:

Dr. Harold Fast, outgoing chairman, Saskatchewan pork producer,

Mr. Weldon Newton, incoming chairman, Manitoba pork producer,

Bill Devereux, Alberta pork producer,

Dr. George Lee, Agricultural Research Coordinator, U of S

Dr. John Patience, Prairie Swine Centre

Mr. Roy Piper, Saskatchewan grain producer,

Mr. Florian Possberg, Saskatchewan pork producer,

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

Mac Sheppard, controller (recently retired), U of S

Dr. John Stewart, Dean of Agriculture, U of S

STAFF AND ASSOCIATES

Executive Management Team
Left to right seated; Dr. John Patience, President/CEO, Mr. Lee Whittington, Manager-Information Services
Left to right standing; Dr. Harold Gonyou, Research Scientist-Ethology, Mr. Brian Andries, Operations Manager, Dr. Yuanhui Zhang, Research Scientist - Engineering.

President

Dr. John Patience is President and Chief Executive Officer of the Corporation. He brings 13 years of experience in extension, the feed industry and research to the Centre. Raised on a hog and beef farm in southern Ontario, he obtained both his Bachelor and Master degrees from the University of Guelph and his Ph.D. from Cornell University, the latter in 1985.

Research Scientist - Engineering

Dr. Yuanhui Zhang is Research Scientist - Engineering. Dr. Zhang obtained his Ph.D. in Agricultural Engineering at the University of Saskatchewan before joining the College of Engineering at the University of Illinois to work on NASA-funded projects on space travel. Dr. Zhang has particular expertise in air quality and environmental control and chairs the sub-committee Environmental Control for Plants and Animals, American Society of Heating, Refrigeration and Air Conditioning Engineers.

Research Scientist - Ethology

Dr. Harold Gonyou is Research Scientist - Ethology (Behaviour). Raised on a farm in southern Ontario, Dr.Gonyou obtained his Bachelors degree from the University of Guelph, his Masters degree from the University of Alberta and his Ph.D. from the University of Saskatchewan. He joined the faculty of the University of Illinois and rose to the position of Professor before leaving to join the Centre. Currently, Dr. Gonyou is President of the International Society of Applied Ethology, the first North American to hold this position. He has also been invited to participate in an international committee focusing on swine equipment design.

Manager - Information Services

Mr. Lee Whittington is Manager - Information Services. Originally from Ontario, he obtained his Bachelors degree from the University of Guelph before joining Shur Gain where he remained for 13 years. In addition to his animal science background, Mr. Whittington has extensive training and experience in marketing and communication, making him ideally suited to his current responsibilities at the Centre.

Manager - Operations

Mr. Brian Andries is Manager - Operations. He hails from southern Saskatchewan and obtained his Bachelors degree from the University of Saskatchewan. Mr. Andries has over 10 years experience in swine production and has risen through the ranks of the Centre to his current position.

In addition to the staff noted above, the Centre is very well served by support staff in a variety of accounting, clerical, production and technical positions. Their combination of training and experience in pork production as well as research methodologies provides the essential support needed in any successful research program.

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. Aki Tanaka
Citizenship - Japan
Degree - PhD Engineering
Last appointment - Ichinoseki Agricultural High School
Area of research - dust control

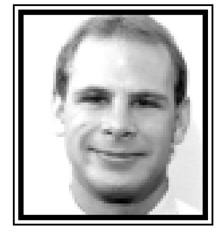
Dr. Zhensheng Lou
Citizenship - Canadian
Degree - PhD Behaviour
Last appointment - University of Guelph
Area of research - animal/equipment interaction

Graduate Students

Renée Bergeron
Degree earned:
Ph.D. in Ethology

Guangzhi Zhao
Degree earned:
M.Sc. in Engineering
Continuing PhD studies

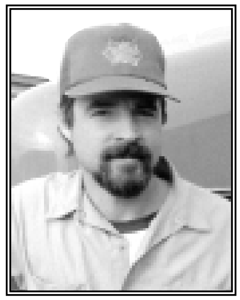
Moira Harris
Degree sought:
M.Sc. in Ethology



Shawn Fairbairn
Degree sought:
M.Sc. in Nutrition

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

Proprietary Research Group
left to right; Ms. Alison Bzowey, research technician, Dr. Eduardo Beltranena, Manager-External Research, Ms. Raelene Petracek, research technician.

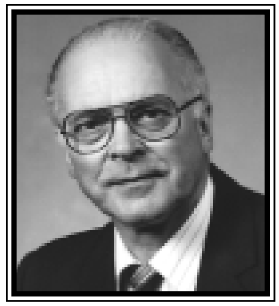


Kelly Sauder,
Farm worker

Standing (L-R) John Meier, Darryl Wurtz, T. J. Hanson, Doug Gillis, Garth McDonald, Karen Wurtz, Marnie Korchinski
Seated (L-R) Joe Jobin, Colin Peterson, Troy Donauer, Alison Bzowey, Raelene Petracek

SCIENTISTS, UNIVERSITY OF SASKATCHEWAN

Dr. Ernie Barber
Professor
Dept. Agricultural and Bioresource Engineering
Research Emphasis: ventilation control and air quality

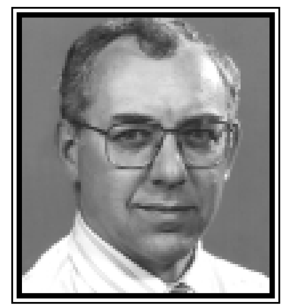


Dr. Milt Bell
Professor Emeritus
Dept. Animal & Poultry Science
Research Emphasis: evaluation of canola meal, peas, barley and wheat

Dr. Bernard Laarveld
Professor
Dept. Animal & Poultry Science
Animal Biotechnology Group
Research Emphasis; endrocine control of metabolism, growth and lactation; immune castration, immune enhancement, neonatal management.

Dr. Iain Christison
Professor
Dept. Animal & Poultry Science
Research Emphasis; sow and litter mngt; piglet and weaning behavior; flooring, crate and pen design

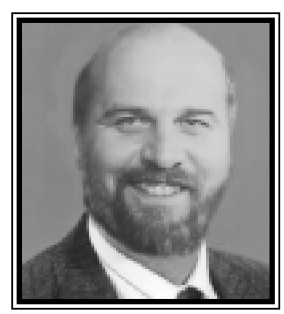
Dr. Al McCurdy
Professor
Dept. Appl. Micro. and Food Science
Research Emphasis; meat processing; extended shelf-life; lipid chemistry



Dr. Chuck Rhodes
Professor
Dept. Herd Med. & Theriogenology
Research Emphasis; swine production medicine

Dr. Phyllis Shand
Research Associate
Dept. Appl. Micro. and Food Science
Research Emphasis; meat processing; product development; sensory properties of meat

Dr. Joseph Stookey
Associate Professor
Dept. Herd Med. & Theriogenology
Research Emphasis; animal behaviour and welfare



Dr. Phil Thacker
Professor
Dept. Animal & Poultry Science
Research Emphasis; improving sow fertility; evaluation of new feeds; gilt management

Research Technicians U of S

Bing Li
Carmen Engele
Anita Lemke
Wayne Morley, Ag. Eng.
Lewis Roth, Ag. Eng.
Charlotte Hampton
Joyce Nordick
Blair Goldade
Susan Francis
Ron Korchinski

Graduate Students U of S

Colleen Christensen
Wenyin Li

Cooperating Scientists

Dr. K. Rajkumar, Reproductive Biology Unit, Obstetrics and Gynecology, Royal University Hospital, Saskatoon, Saskatchewan
Dr. Shin-ichi Urano, Hokkaido University, Japan
Dr. John Feddes, University of Alberta, Edmonton
Dr. Laurie Conner, University of Manitoba, Winnipeg
Dr. Jim Dosman, Centre for Agricultural Medicine, U of S.
Dr. A. Senthilselvan, Centre for Agricultural Medicine, U of S.
Mr. J. Strom, National Institute for Agricultural Engineering, Denmark
Dr. P. Willson, VIDO
Prof. W.T. Martin, Royal University Hospital, Saskatoon, Saskatchewan
Dr. M. Sheridan, Steinbach, Manitoba

Production Technician Joe Jobin moving a boar out of breeding pen

FINANCIAL SUPPORT

Pork production research is entering a new phase in Canada, with increasing emphasis on producer driven and funded programs. Prairie Swine Centre Inc. wants to acknowledge the many individuals and agencies that supported the dynamic 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 1994/1995 year. Their support is greatly appreciated.

Pork Producers of Saskatchewan
SPI Marketing Group
Swine Improvement Services Co-op

Pork Producers of Alberta
Alberta Pork Producers Development Corporation

Pork Producers of Manitoba
Manitoba Pork Est.

Government
Alberta Agricultural Research Institute
Agricultural Development Fund
Canada-Saskatchewan Green Plan Agreement
Western Economic Diversification Program
Natural Sciences and Engineering Research Council of Canada (NSERC)
Industrial Research Assistance Program (IRAP)

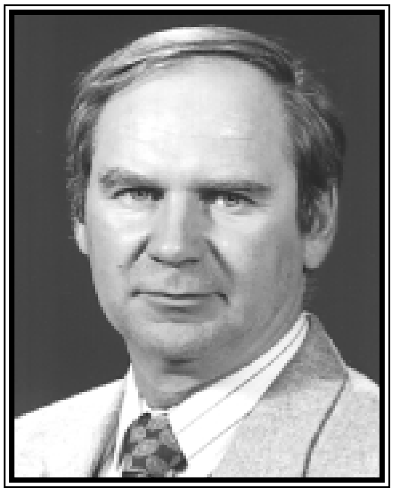
Institutions outside Canada
United States Department of Agriculture (USDA)
University of Maryland

Industry Donations
Feed Flavors Incorporated
Canola Council of Canada
Pig Improvement (Canada) Ltd.
Saskatchewan Canola Development Commission
ADM Bioproducts
Del Air Systems Ltd.
Canodev Research
Degussa Corporation

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.

Alberta Swine Genetics
Calmar Feed Mill Ltd.
Canadian Imperial Bank of Commerce
Canola Council of Canada
Cotswold Western Canada
dgh Engineering
East-man Feeds
Elanco Animal Health
Federated Co-operatives Ltd.
Feed-Rite Ltd.
Finer Feeds Ltd.
Western Feed Mill Ltd.
Hillcrest Farms Ltd.
Intercontinental Packers
Managro Harvestore
New Life Feeds
Nutrena Feeds
Phason
Prairie Pride Enterprises
Puratone
SPI Marketing Group
Unipork
University of Saskatchewan (Capling Fund)
Upjohn company-Animal Health
Veterinary Infectious Disease Organization (VIDO)

CHAIRMAN'S REPORT



Harold Fast
Chairman of the Board

Prairie Swine Centre continues to break new ground in science and communications. In the short period since the inception of the Centre as a non-profit corporation (1991), we have seen steady growth in the physical and intellectual assets of the company. The Centre is now recognized in many parts of the world as a significant contributor to the body of practical pig knowledge as well as contributing to our basic understanding of the pig and how it interacts with its environment.

It is a compliment and a tribute to Centre staff , when we hear the Centre referred to as an example of how research, development and particularly technology transfer should be done.

This will be my last report as chairman and as such it may be appropriate to discuss how and why the Centre has enjoyed such success in a relatively short period of time. The support of progressive pork producers really forms the core of this story. In 1986 when the advisory board was established, it was clear that given the resources at that time more could be done to provide producers with information that could improve productivity. As the advisory board matured and gained further industry input from all levels, the needs became broader and better defined. For example, the concept of industry sustainability was regarded as equally important to the economics of production in the light of intense interest by consumers and producers alike in animal welfare. The concept of sustainability grew to include concerns of where hog barns would be sited, and their impact on the environment. Finally, an industry is only sustainable as long as it has a devoted work force and the demographics of that work force are changing rapidly. Once the domain of family labour, larger swine buildings meant a further need for additional labour. People now spend their entire working day in the barn, the effect of the working environment on the health of both pigs and people was clearly an area we needed to know more about.

From this consultative process, plans were made with university and government to change ownership and the business structure at the Centre to allow for expansion of the Centre to address productivity and sustainability issues through a series of five objectives in the areas of nutrition, behaviour and engineering.

Once established, the Centre sought the personnel and structures needed to make a contribution to the industry. In developing the actual research priorities several 'round table' sessions were held to ensure that the broader industry had direct input and access to the Centre. Something that management and staff of the Centre have continued to emphasize during the course of the last three years. Was the 'experiment' successful?

Since mid 1992, when the Centre came up to full staff, the original five year objectives have gone from challenging to doable to done! For example, objective #1 was designed to reduce the cost of production by $2 per pig. At last count several successful nutrition studies have contributed nearly $11 per pig. It is clear that the more we know about the pig, the more we realize there are ways to improve the way we handle the care and feeding to achieve optimum results.

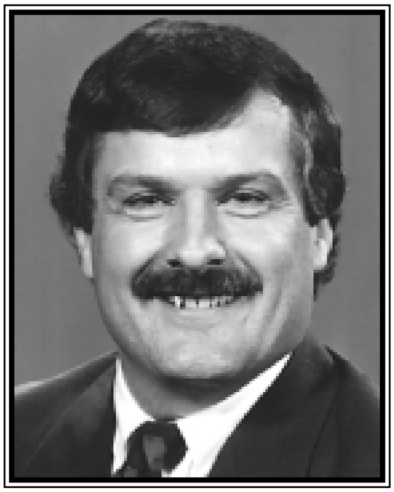
The final element of success with such a research program is of course the rapid adoption of the new technology by a ready and willing industry. 'Knowledge, it is said, is power' but the resource can go untapped unless pork producers put their faith in the research they have funded and begin using it to improve the profitability and sustainability of their own farms. There were several signals this year that pork producers in western Canada are ready and able to make such commitments. In April, the delegates to the SPI Annual Meeting approved a motion to continue providing the $0.25/pig check off in support of the Centres' research and technology transfer programs. The Alberta Pork Producers also voted in favour of renewing their commitment to the Centre started a year ago. Manitoba pork producers had previously announced a three year commitment for research funding at PSC.

I would like to thank the many people who served on the Advisory Board, the Board of Directors, and various committees. Like the Centre, I too have grown with their vision and confidence.

We are all deeply indebted to Dr. John Patience who has been able to take the policy direction of the Board and through recruitment of competent people formulate a great success story. John has given a tremendous amount of leadership, vision and commitment toward the success of Prairie Swine Centre. He has truly shown that the impossible just takes longer!! On a more personal note, while we recognize the contributions John makes to our industry we need to respect Ann Patience for the extra amount of time she spends covering for John. Thank you Ann.

An aerial view of the Prairie Swine Centre.
The Grower/Finisher unit is the "L" shaped building in the foreground.

PRESIDENT'S REPORT



Dr. John Patience
President

This is the third Annual Research Report published since the Prairie Swine Centre re-organized in 1992. As in previous years, it contains a combination of reports of specific experiments as well as review articles on selected topics. We are pleased to again welcome contributions from the campus of the University of Saskatchewan.

In 1994-95, the Prairie Swine Centre continued to grow in both size and stature. Our technology transfer program introduced a number of new initiatives, including the highly successful satellite conference and a charter trip to the World Pork Expo. Our scientists received national and international recognition this year, including the prestigious Andrew Fraser Award presented to Dr. Harold Gonyou and the title of Honorary Professor bestowed upon Dr. Yuanhui Zhang by two institutions: the Beijing University of Agricultural Engineering and the Shandong Institute of Technology during a trip to the People's Republic of China.

Dr. Eduardo Beltranena has lead our contract research program through rapid expansion, now employing 3 full-time staff and attracting projects by companies from across North America and Europe. Not only does this activity improve the financial position of the Centre, it also helps to increase the awareness among international agribusiness of the dynamic and efficient pork industry in this region.

Board of Directors

An important milestone for the Centre occurred this year with the retirement of Dr. Harold Fast, of Spiritwood, SK as Chairman of the Board. His term as Director will expire in October. Harold has been associated with the Centre one way or another since 1986. He was appointed to the first Advisory Board in 1988 and to the Board of Directors of Prairie Swine Centre Inc. in 1991. His vision of the future, as well as his dedication to the process of restructuring and refocusing the Centre played a significant role in our current success. All of the staff of the Centre join me in acknowledging with gratitude the tremendous contribution of Dr. Fast; in recognition of almost 10 years of involvement in the Centre's activities, the 1995 Annual Research Report is dedicated to Harold Fast.

Two other Directors will also retire in October. Mr. Roy Piper of Elrose, SK is Saskatchewan Vice-President of the United Grain Growers and also a grain and pork producer. Roy served the Centre extremely well with his eye for business management, his emphasis on longer-term planning and his thoughtful input on many issues. He was a Director of Prairie Swine Centre Inc. for 3 years. Mr. Bill Devereux, former Chairman of the Alberta Pork Producers Development Corporation and a pork producer at Fort Saskatchewan also retired after three years on our Board. Bill's dedication to the Centre's vision and his outspoken contribution on the many issues facing the Board encouraged us to remain true to our primary focus and direction. The staff of the Centre acknowledge with gratitude the important contribution of Messrs. Piper and Devereux to our success.

Funding

The success of the Centre is dependent on the funding it receives from many sources. The three largest sources of funds are the federal government, through the Western Diversification Program, the pork producers of Saskatchewan, through their checkoff and the Province, through the Agricultural Development Fund. At the semi-Annual meeting held in the Fall, delegates voted to renew the Centre's funding for an additional three years.

This year, we welcomed 7 new funding sources: Manitoba pork producers, through Manitoba Pork Est., Winnipeg,MB, Canodev, Saskatoon, SK, ADM Bioproducts, Decatur, IL, Canola Council of Canada, Winnipeg, MB, the Canada-Saskatchewan Green Plan Agreement, Saskatoon, SK and the United States Department of Agriculture, Washington, DC. The support of these organizations builds on the base of our major funders, increasing the productivity of our scientists and expanding and enhancing our total research effort.

We continued to receive financial support from Alberta pork producers through the Alberta Pork Producers Development Corporation and from Pig Improvement Canada. A complete list of funding agencies and organizations appears elsewhere in the Annual Report.

Strategic Plan

Prairie Swine Centre Inc. has existed as a non-profit corporation since April, 1991 and has functioned as a research organization since April, 1992. With 3 years of experience, the time seems appropriate to review our strategic plan, considering the original vision in the context of a rapidly changing industry. A draft plan has now been prepared and reaction is being obtained from pork producers, government agencies and agribusiness.

The revised plan, which I emphasize is still in draft form, continues to place major emphasis on high quality research directed at key industry issues of economic competitiveness and sustainability, on an aggressive technology transfer program, on fiscal responsibility and business management and on education. We will continue to seek input from the industry we serve before finalizing this strategic plan.

Consulting

There has been considerable demand from the industry to utilize the expertise of the Centre's staff to address specific problems on their farm or on their clients' farms. This activity goes beyond the traditional role of technology transfer which seeks to communicate research results to the industry. While we have welcomed this opportunity to serve the industry in another way, it presents a problem as it takes time away from our central role - to conduct research and provide new information to solve problems or increase opportunities for all producers.

On the other hand, consulting on an individual basis can be a very positive activity, as it represents an excellent opportunity for our staff to keep informed of industry issues and how producers are applying technology on their farm. In an attempt to address this issue, an Advisory Board was established with representation from across the three Prairie provinces. The membership is listed in the box below. This Advisory Board provided input for a consultant who was hired to conduct a feasibility study; as such, the Board's discussion focused on what services are required and who required them, how to best provide the the service and other relevant issues.

Advisory Board on Consulting Services

S. Bond, SK
R. Charbonneau, AB
B. Everitt, SK
C. Froese, SK
B. Henley, SK
M. Jorgenson, SK
D. Milligan, AB
N. Shantz, SK
B. Steeds, MB
G. Tolton, MB
W. Vermette, SK
P. Volk, SK

Consultant

D. Hoover, AB

Ex Officio

J. Patience, SK
L. Whittington, SK

A final report will be presented to the next meeting of the Board of Directors of Prairie Swine Centre Inc. for consideration.

Research

This was a particularly productive year for our research program. Focusing on issues of economic efficiency and sustainability, our staff can point to more than $10.00 per pig in potential savings by implementing research completed at the Centre. This represents a return on the 25 cent checkoff of 32 to 1!

Part of this success accrues from the planning process associated with the research program; by focusing resources on areas of greatest need and potential return, the Centre's scientists are able to achieve success in a planned and co-ordinated fashion. Of note here is the role of technology transfer, which not only moves information out from the Centre, but also receives feedback on our research to allow fine tuning of our planning and co-ordination activities.

Another reason for the success is the emphasis placed by our scientists on economic return. Because industry funding plays a large roll in our future, we feel a strong need to provide a good return on that investment. However, the most significant contributor to our success is our staff, from the scientists who direct the research to the technicians who carry it out. Without their skills and dedication, the success of the Centre would be measured in pennies rather than dollars!

Technology transfer

The Centre's technology transfer program achieved remarkable success under the leadership of Lee Whittington. With excellent support and involvement by the Research Scientists, Lee continued publication of our quarterly newsletter Centred on Swine, organized a highly successful Spring Conference series which included our first Satellite Conference and placed articles in a variety of trade magazines.

Staff from the Centre present literally dozens of speeches to industry and academic organizations around the world. For example, Dr. Gonyou averages approximately 70 nights away from home in a typical year! This contact with the industry and the academic community not only ensures rapid transfer of research results from the Centre to our industry, but it also provides ample opportunity to learn about industry issues, to become familiar with research conducted at other research facilities and to develop contacts which often lead to highly productive collaborations.

Production

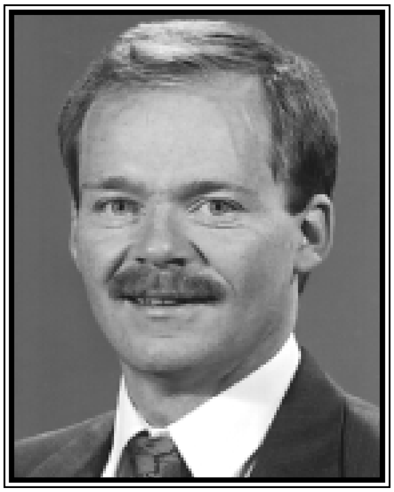
This was not a banner year for the production component of the Centre, as a TGE outbreak caused heavy mortality for a 3 week period in April. However, the staff, under the direction of Brian Andries tackled the problem head-on. The results speak for themselves. Despite the TGE outbreak, the Centre's 280 sow herd weaned 22.9 pigs per sow in inventory, averaged 11.1 pigs born alive per litter and 12.9% preweaning mortality. A great deal of credit for this success must go to our staff who dedicate themselves to maximizing the productivity of our herd.

The Future

Like pork production itself, research is changing. While the pace may not be the same, the structure of the research community is very different today than it was a decade ago. Many challenges await us on the road ahead, but in many cases, these challenges also represent opportunity if handled correctly.

We are very excited about our new strategic plan and the vision of the future it foresees; we believe very strongly in the future of the Canadian pork industry, but know that success in an increasingly competitive international market will require attention to four primary factors: financing, marketing, technology and people. The Centre's function is to contribute to the industry's need for modern technology to maintain our competitive advantage. We can also assist in the area of personnel training. We welcome your input and invite you to contact with ideas, suggestions and yes, even criticisms, to allow us to serve the pork industry as best we can.

INFORMATION MANAGER'S REPORT



Lee Whittington
Manager-Information Services

Technology Transfer Report

The inventor is epitomized in the words of Thomas Edison "There's a better way to do it. Find it."

Technology transfer would rewrite it perhaps as; "There's a better way to do it. Find it and teach someone how."

This year, the financial support and encouragement from pork producers in Saskatchewan, Alberta and Manitoba made it possible to offer a variety of programs across the entire prairie region. This added geography presented some new opportunities to utilize additional technologies such as the FBMInet and satellite conferencing to enhance the communication with pork producers, extension and agribusiness. The year began with a review of the collective activities of the technology transfer team. At the Centre everyone has a role to play in technology transfer; the scientists devote approximately 20% of their time, and Dr. Eduardo Beltranena joined the staff this year with part of his mandate being technology transfer in addition to his contract research responsibilities.

Farm calls and direct producer contact became a larger component as we sought candid comments from the industry regarding the effectiveness of the program. This aspect of actively listening is an integral component of technology transfer and provides a constant source of new inspiration. For example, two issues of Centred on Swine were rewritten this last year to include more information on water at the request of several producers and industry personnel that identified that as one area they felt needed more attention.

In terms of information leaving the Centre, there were more presentations made in western Canada by PSC personnel than ever before, over 90 in total. Printed publications saw Centred on Swine's seventh issue distributed to over 5000 readers, the Annual Research Report circulation increased to 1800 and displays were set up at trade fairs from B.C to Ontario. The newest and largest communications project, the Satellite Conference was held for the first time in March 1995. A listing of some of the technology transfer events this past year are shown in Table 1.

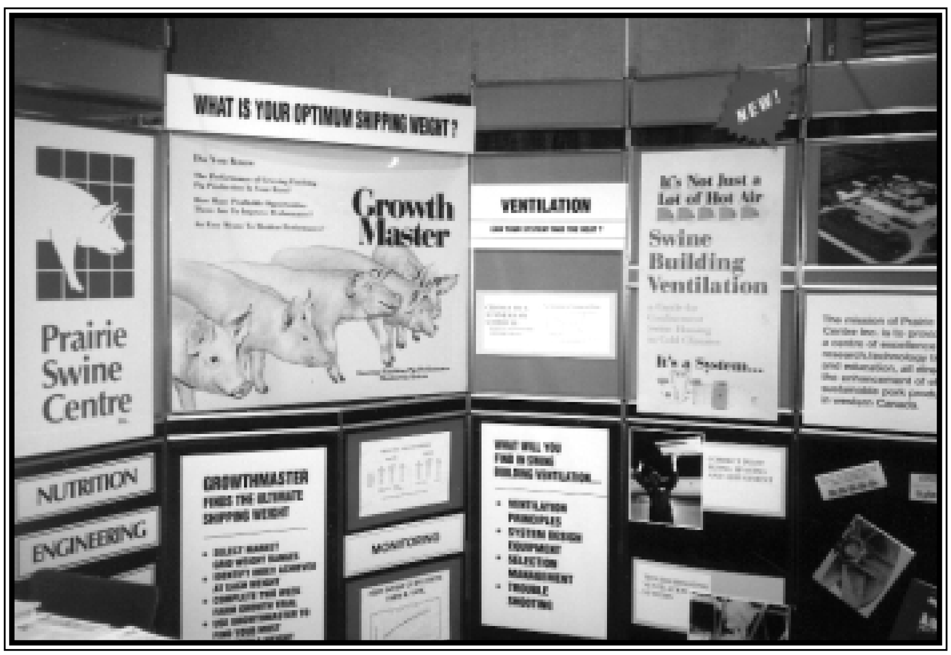
Satellite Conference

This interactive half-day program proved very popular from the beginning. Sites or 'down-links' as they are technically called were organized by the Centre in 30 locations across the prairies. Local extension, university and agribusiness volunteers acted as site facilitators to ensure that conference attendees were well looked after. Over 440 participants attended the conference making it the largest single swine event in western Canada. Size by itself is not a good measure of success. The real proof was in the evaluations, over 98% said they would attend a future satellite conference. Next year we will be repeating the conference, modifying it to take advantage of the suggestions received from participants this year and attempting to address the desires of other regions of Canada to become involved.

Another new event was added this year, that linked the three western provinces by air. The first of what is expected to be an annual trip to World Pork Expo and surrounding territory was initiated by the Centre. Seventeen pork producers, feed and equipment manufacturers, extension and university personnel pooled their resources to charter a flight to Des Moines, Iowa. The flexibility of the charter allowed the group to spend a day with a large veterinary clinic in Minnesota that is pioneering work in SEW technologies. The ability to discuss candidly with the veterinarian and the producer, the challenges of managing two barns that each house 4000 early weaned piglets situated 100' apart was the highlight of the tour for many .

Dr. Yuanhui Zhang - Research Scientist Engineering introduced his first book, Swine Building Ventilation- A Guide for Confinement Swine Housing in Cold Climates. Pork producers, agricultural engineers, and barn contractors will all find this easy-to-read guide a handy reference for designing or renovating heating and ventilation systems.

The goal of the technology transfer program is to continue to offer programs that increase the rate of adoption of new technologies, whether they are created at PSC or elsewhere, by Canadian pork producers. Although new technology is just one important component of future success, the others being financing, reliable labour and marketing, it is the one we have the most control over on a daily basis. We welcome your suggestions for new ways to maintain our competitive advantage as a supplier of pork to the world.



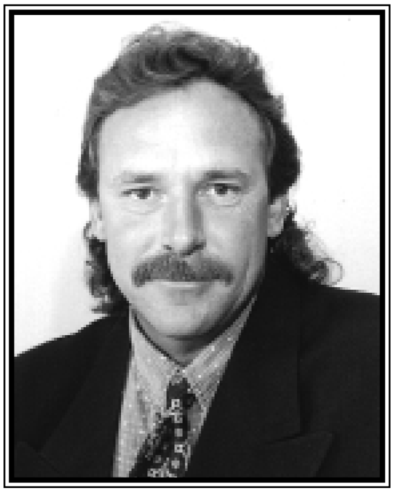
Prairie Swine Centre Display at the Alberta Pork Congress.

In 1995, the technology transfer program was expanded to include information displays at major industry events in Saskatchewan, Alberta, Manitoba and Ontario.

List of Technology Transfer activities during the past year

Medium	Frequency	Reach	Target Audience
Presentations at Producer Meetings	90		pork producers, suppliers
Annual Report	once a year	2000	pork producers shipping >1000 head/yr, researchers, funding agencies
Centred on Swine	4 times per year	5000	pork producers, suppliers, government
Satellite Conference Proceedings	once a year produced by PSCI		1100 pork producers, suppliers
Proceedings	centre personnel contribute papers to scientific & industry proceedings	20+	scientific community & industry
Factsheets	as needed	5000	pork producers, suppliers
Books	two currently, Swine Nutrition Guide & Ventilation Guide	4000	pork producers, suppliers
Popular Press	10 + per year		Canadian pork producers
Trade Fairs	5 last year		producers, agribusiness and extension
World Pork Expo Tour	once a year		producers, agribusiness, extension
Software	GrowthMaster		pork producers, suppliers

OPERATION MANAGER'S REPORT



Brian Andries
Operation Manager

Fiscal year 1994/95 brought to Prairie Swine Centre, and other producers throughout Canada, a greater appreciation for the importance of a workable and reliable on farm Biosecurity procedure, after seeing the effects that the out-break of Transmissible Gastroenteritis had on the productivity of many herds as well as the economic effects of lost revenues and extra costs accrued as a result of the disease. For the Swine Centre, other effects were evident in the amount of Internal and Contract research that could not be conducted over the period of time that the disease ran it's course with pre-wean mortality levels approaching 100 %, later resulting in lower number of animals available for Starter and Grow-Finish trials.

The greatest effect on myself, as Manager, and production staff, was seeing death losses on 3-4 day old piglets as a result of the virus , before a high level of active immunity in the sow herd could be established through our Feed-back program. Losses were minor on animals 10 days of age and older, and little effects were seen in the grow-finish and breeding herd except for a few days of decreased feed intake and growth.

An important effect of the disease for us, was to reexamine our Biosecurity Procedures to ensure that we can eliminate the entrance of other bacterial and viral diseases to the Centre, especially with the impending threat of Porcine Reproductive and Respiratory Syndrome on the horizon.

Staff and visitor Biosecurity training sessions have been established, and all Procedures were reevaluated when it came to hauling feed, both bulk and bags, as well as transporting animals. A bus was purchased to haul market animals, reducing the number if weekly trips to Intercontinental Packers, thereby reducing the risk of disease entrance while transporting livestock. As before, vehicles are power washed before returning back to the Centre. The entrance of all materials, supplies, and equipment is monitored and will be brought in through a biosecurity room that is separated from the barn and has it's own wash, disinfecting and fumigating capabilities, so all materials can be cleaned before barn entry.

In spite of the 462 animals lost to T.G.E., we were still able to surpass the previous years production levels as demonstrated in the table below:

	94/95	**93/94**
Number of sows farrowed	634	650
Farrowing rate, %	86.7	87.6
Average pigs born alive/litter	11.1	10.7
Numbers of litters weaned	648	650
Total pigs weaned	6310	6097
Pigs weaned/female inventory/year	22.9	22.1

To make up for loses occurring from the T.G.E. outbreak, an extra 40 gilts will be farrowed out and then marketed, in the hopes of increasing the number of animals marketed in 1995/96, recuperating some of our losses from the previous year.

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 also 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 will be 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 improve the air quality of hog barns for both pigs and people. Air quality within swine building airspaces is important in establishing the productivity, health and well-being of animals and the health and well-being of operators. The contaminant concentration within the barn will be measured, the rates of generation and spatial distribution of contaminants will be modeled, and control strategies to improve the air quality will be developed.

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.

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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 analyses are included to increase the confidence you can place in the results.

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Technician Colin Petersen weighs feed into feeder in one of the 'engineering' rooms

WHEY REPLACEMENT FOR NURSERY DIETS

SPRAY-DRIED BLOOD CELLS AND LACTOSE CAN REPLACE WHEY IN PHASE I NURSERY DIETS

Eduardo Beltranena, Alison L. Bzowey and Raelene A. Petracek

Summary

Spray-dried whey and skim milk have long been used in nursery diets as sources of high quality protein and lactose (milk sugar). More recently, further processing of these dairy industry byproducts has resulted in deproteinated whey and pure lactose being available at economical prices. Likewise, further processing of rendering blood products has resulted in spray-dried plasma and red blood cells being available at economical prices. Spray-dried plasma is now commonly used as a high quality substitute for the milk protein traditionally supplied in nursery diets using skim milk. Spray-dried blood cells is a product with an extremely high lysine content which has been shown to partially or totally replace fish meal in nursery diets. More recently, we have been questioning whether spray-dried blood cells and lactose could partially or totally replace whey economically in nursery diets.

One hundred and forty four pigs weaned at 17±3 days were used in a three-week long trial. The objective was to compare the effects of the partial (50%) or total (100%) substitution of whey by spray-dried blood cells and lactose in Phase I (0 - 21 d postweaning) nursery diets. Pen feed disappearance and individual pig body weights were recorded weekly; pen average daily weight gain, feed disappearance and feed:gain ratios for each weekly period and overall were then calculated.

For any weekly period or overall, average daily weight gain and feed disappearance were not different between pigs offered the control diet or the diets in which whey was partially or totally replaced by spray-dried blood cells and lactose. Moreover, the pigs offered the diets in which whey was partially or totally replaced by spray-dried blood cells and lactose had significantly better feed:gain ratios than those pigs fed the control whey diet during the third weekly period and overall.

The results of this trial, not only indicate that a combination of spray-dried blood cells and lactose can partially or totally substitute whey in Phase I nursery diets, but also showed that the feed conversion efficiency of weanling pigs can be improved.

Experimental Procedure

One hundred and forty four pigs, weaned at 17±3 days were used in this trial. These pigs were not offered any creep feed or milk replacement in the farrowing rooms prior to the start of the trial. The pigs were selected from two consecutive weeks of farrowings. Ear notches identified litter of origin and pig number in the litter.

The trial was conducted in two identical nursery rooms. Each room housed 72 pigs in 18 pens, four pigs per pen. The pigs were weighed the day before weaning and sorted into weight groups (blocks). On the day of weaning the pigs were moved to the nursery room, weighed and distributed to their assigned pens. The treatment diets were then randomly allocated to pens within blocks. Gender and litter of origin were balanced across treatment as much as possible.

The corn-based diets offered were (Table 1):

- 17.5% SBM + 15% whey
- 17.5% SBM + 7.5% whey + 5.3% lactose + 1.0% spray-dried blood cells
- 17.5% SBM + 10.6% lactose + 2.0% spray-dried blood cells

The diets were formulated to contain 1.4% total lysine. Crystalline amino acids (lysine HCl, L-threonine, DL-methionine and L-tryptophan) were added to standardize the level of total threonine, methionine and tryptophan in the diets to 0.97, 0.40 and 0.18%, respectively. Mono-dicalcium phosphate and salt were also added to equalize phosphorus and sodium levels. The spray-dried whey used (Kraco®-Kraft General Foods Canada Inc.) was reported to contain a minimum of 11% CP, 70% lactose and 1.35% sodium.

The pigs were offered the treatment diets for a period of three weeks. The treatment diets were offered free-choice from self-feeders located at the front of each pen. The pigs also had free access to water from nipple drinkers located at the back of the pen.

Table 1. Experimental Diets

	Whey control	50% whey substitute	100% whey substitute
Ingredients, %			
Corn	50.35	51.00	51.59
Spray dried whey	15.00	7.50	
Soybean meal	17.50	17.50	17.50
Lactose		5.30	10.60
Spray-dried plasma	5.00	5.00	5.00
Spray-dried blood cells		1.00	2.00
Select menhaden meal	2.50	2.50	2.50
L-Lysine HCl	0.10	0.125	0.15
L-Threonine	0.025	0.08	0.14
DL-Methionine	0.075	0.10	0.12
Limestone / glass rock	1.40	1.40	1.40
Mono/dicalcium phosphate	1.50	1.75	2.00
Salt		0.20	0.45
Zinc oxide (72% Zn)	0.25	0.25	0.25
Choline chloride 60%	0.05	0.05	0.05
Vitamin premix	0.50	0.50	0.50
Trace mineral premix	0.50	0.50	0.50
Medication	0.25	0.25	0.25
Canola oil	2.50	2.50	2.50
Tallow	2.50	2.50	2.50
Calculated analysis			
Calcium, %	1.01	1.01	1.01
Phosphorus -total, %	0.80	0.80	0.80
Lactose, %	10.50	10.50	10.49
DE, MJ/kg	15.03	15.03	15.03
Crude protein, %	19.92	20.19	20.47
Lysine -total, %	1.40	1.41	1.41

[a] Provided the following per kg of premix: vitamin A 1,650,000 IU, vitamin D 165,000 IU, vitamin E 8,000, menadione 800 mg, thiamin 200 mg, riboflavin 1,000 mg, niacin 7,000 mg, d-pantothenic acid 3,000 mg, vitamin B12 5 mg, biotin 40 mg and folic acid 400 mg

[b] Provided the following per kg of premix: copper 10 g, iron 16 g, manganese 5 g, zinc 20 g, iodine 100 mg, selenium 20 mg

The pigs were individually weighed at the start of the trial, and thereafter, every week over the three week nursery period. Feed disappearance was measured on a per pen basis as the difference between the weight of the feed added and the weight of the feed recovered weekly during the trial. Pen average daily weight gain, feed disappearance and feed:gain ratios for each weekly period and overall were then calculated.

Results

Table 2 summarizes the effects of whey replacement on pen average daily weight gain, feed disappearance and feed:gain ratios. For any weekly period or overall, average daily weight gain and feed disappearance were not different between pigs offered the control diet or the diets in which whey was partially or totally replaced by spray-dried blood cells and lactose ($P > 0.05$). Feed:gain ratios were not affected by treatment during the first week of the trial ($P = > 0.05$). However, there was a significant effect of treatment diet on feed:gain ratios during the third week period and overall: Pigs fed the diets in which whey was partially (50%) or totally (100%) substituted by spray-dried blood cells and lactose, converted more efficiently than those pigs fed the control diet containing whey (P= <0.05). A similar numeric trend was evident for the second week of the trial, but it did not reach significance (P= > 0.13).

Table 2. The effect of whey replacement in Phase I nursery diets on pen average daily weight gain (kg), feed disappearance (kg) and feed:gain ratios (kg:kg) of weaning pigs

	Whey control	50% whey substituted	100%whey substituted substituted	*P* value
n, pens	12	12	12	
Daily weight gain, kg				
0 - 7 d	0.16	0.16	0.15	0.64
8 -14 d	0.39	0.40	0.39	0.42
15 - 21 d	0.53	0.54	0.56	0.37
0 - 21 d	0.36	0.36	0.37	0.74
Daily feed disappearance, kg				
0 - 7 d	0.22	0.24	0.21	0.72
8 -14 d	0.47	0.47	0.45	0.63
15 - 21 d	0.73	0.69	0.70	0.41
0 - 21 d	0.47	0.46	0.46	0.76
Feed:gain, kg:kg				
0 - 7 d	1.39	1.41	1.41	0.99
8 -14 d	1.21	1.18	1.16	0.13
15 - 21 d	1.41^a	1.28^b	1.25^b	0.01
0 - 21 d	1.33^a	1.27^b	1.24^b	0.01

^{a,b} Means in a row with different superscript letters differ (P < 0.05)

Conclusion

The results of this trial not only indicate that a combination of spray-dried blood cells and lactose can partially or totally substitute whey in Phase I nursery diets, but also showed that the feed conversion efficiency of weaning pigs was improved. Despite the fact that the spray-dried blood cells and lactose added diets were more expensive, cost per kilogram of body weight gain for the pigs fed these diet was lower than that of the pigs fed the control diet (Table 3).

Table 3. Brief economic analysis

	Whey control	50% Whey substituted	100% Whey substituted
kg gained 21 d	7.56	7.56	7.77
kg eaten 21 d	9.87	9.66	9.66
$/kg diet	$0.65	$0.66	$0.67
$ spent in feed	$6.39	$6.35	$6.43
$/kg gained	$0.85	$0.84	$0.83

Acknowledgment

This trial was commissioned and financed by American Protein Corporation, who have generously granted permission to publish these results in this public document.

REMOVAL OF VITAMINS AND TRACE MINERALS FROM FINISHING DIETS: IMPACT ON ANIMAL PERFORMANCE

John F. Patience and Doug Gillis

Summary

Maximizing net income from pork production requires consideration of all aspects of diet formulation. Energy is the most expensive component of the diet, followed closely by amino acids. While representing a smaller portion of the total feed bill, minerals and vitamins still represent a significant expense, one which needs to be reflected in benefit to the pig and value to the pork producer.

The finishing phase of production was targeted in this study because this is the period when most of the feed is consumed. In addition, it is known that certain vitamins are effectively stored in the liver and fatty tissue and also that cereal grains and other dietary components contain significant quantities of at least some of the vitamins which are less effectively stored by the pig. With animals destined for market, there would be no need to consider the impact on subsequent reproductive performance.

This experiment was conducted to determine if removal of vitamins and trace minerals from the finishing diet for periods of approximately 3 or 5 weeks prior to slaughter would affect animal performance and carcass merit.

No differences among treatments were observed, suggesting that removal of such supplements may be an effective way to reduce the cost of production without affecting animal performance or well-being. The economic benefit of such a change will vary among farms, depending on the current cost of supplementation; it is estimated that a typical savings of about $1.00 per pig sold may be realized.

Experimental Procedure

A total of 525 pigs were selected at approximately 80 kg and assigned in pens of 11 or 12 to one of 3 dietary treatments (Table 1):

- basal diet (control)
- basal diet with vitamins and trace mineral supplements removed for the final 3 weeks before expected marketing
- basal diet with vitamins and trace mineral supplements removed for the final 5 weeks before expected marketing.

A total of 15 pens were assigned to each treatment. Pigs remained on their respective dietary treatment until the day of marketing. Unlike the supplemental vitamins and trace minerals, calcium. phosphorus and salt were supplemented throughout to market weight.

Results

The performance of the pigs was unaffected by dietary treatment (Table 2). Treatment 2 pigs averaged 17 days before market without vitamin or trace mineral supplementation; Treatment 3 pigs were without supplementation for 36 days prior to marketing.

Average daily weight gain, daily feed, feed conversion efficiency and days to market were not affected by treatment ($P > 0.05$). Indeed, there was a trend for pigs that received no vitamins or trace minerals for the final 36 days before marketing to have a slightly better feed conversion ($P < 0.10$); we suggest this is an artifact and not an effect of dietary treatment as there is no biological explanation for this response.

Similarly, carcass traits were unaffected as well ($P < 0.05$; Table 3). In this experiment, dressing percentage was quite high, averaging 84%. Carcass index, at 102.2, was very much below average for the PSCI herd; this occurred because the dressed weights exceeded the core area of the grading grid. With yields approaching 60%, lean thickness averaging 60.6 mm and fat averaging 22.2 mm, carcass quality was quite good. The breakdown of carcass traits by sex is summarized in Table 4. As expected, all traits were affected by sex ($P < 0.05$). The data also revealed some treatment by sex interactions, meaning that males responded to the dietary treatments differently from females. However, these differences were small and probably of little or no commercial significance.

Table 1. Experimental diets

	Supplemented	Not supplemented
Ingredients, %		
Wheat	38.00	38.00
Barley	45.72	45.12
Soybean meal	8.00	8.00
Canola meal	5.00	5.00
Limestone	1.00	1.00
Mono/dicalcium phosphate	0.70	0.70
Salt	0.40	0.40
Lysine HCl	0.08	0.08
Vitamin premix[a]	0.30	-
Mineral premix[b]	0.30	-
Oil	0.50	0.50
Calculated analysis		
DE, kcal/kg	3210	3210
Lysine - total, %	0.76	0.76
Lysine - digestible, %	0.59	0.59
Threonine - digestible, %	0.38	0.38
TSAA - digestible, %	0.50	0.50
Calcium, %	0.60	0.60
Phosphorus - total, %	0.52	0.52
Phosphorus - available, %	0.27	0.27
Sodium, %	0.18	0.18
Chloride, %	0.32	0.32

[a] Provided the following per kg of premix: vitamin A 1,650,000 IU, vitamin D 165,000 IU, vitamin E 8,000, menadione 800 mg, thiamin 200 mg, riboflavin 1,000 mg, niacin 7,000 mg, d-pantothenic acid 3,000 mg, vitamin B12 5 mg, biotin 40 mg and folic acid 400 mg

[b] Provided the following per kg of premix: copper10 g, iron16 g, manganese 5 g, zinc 20 g, iodine 100 mg, selenium 20 mg

Table 2. Effect of vitamin and trace mineral removal on pig performance.

	TREATMENTS			
	1	**2**	**3**	P value
No. pigs	176	175	171	
Initial wt., kg	81.6	80.8	81.4	NS
Final wt., kg	107.9	106.8	107.7	NS
Days without supplemental vitamins and trace minerals	0	17.0	36.5	
Daily weight gain, kg	0.890	0.878	0.893	NS
Daily feed disappearance, kg	3.061	2.996	2.962	NS
Feed:gain	3.43	3.42	3.33	0.10

[1] Basal diet (control)

[2] Basal diet with vitamins and trace mineral supplements removed for the final 3 weeks before expected marketing

[3] Basal diet with vitamins and trace mineral supplements removed for the final 5 weeks before expected market

The final consideration is economics. Although the financial impact of this research will vary among farms, due to differences in how this information is applied, we have calculated that removing the vitamin and trace minerals from the finishing diet would reduce the cost of feed by between $6 and $12 per tonne, depending on the current level of supplementation. On this basis, removing the trace elements for the final 17 days would improve net income by about $0.46 per pig, while removing them for 36 days would save about $0.98/pig. These results are particularly significant in that no apparent effect on performance was observed.

Table 3. Effect of supplemental vitamin and trace mineral removal on carcass traits

	Treatments			P value
	1	2	3	
Dressed weight., kg	90.6	89.3	91.0	NS
Index, %	102.0	102.7	102.6	NS
Yield, %	59.2	59.4	59.4	NS
Lean, mm	60.6	60.6	60.8	NS
Fat, mm	22.4	22.2	22.0	NS

[1] Basal diet (control)
[2] Basal diet with vitamins and trace mineral supplements removed for the final 3 weeks before expected marketing
[3] Basal diet with vitamins and trace mineral supplements removed for the final 5 weeks before expected marketing

However, two cautions must be noted. First, if animals are being kept for breeding purposes, the removal of vitamins and trace minerals is not recommended. Second, the impact of vitamin and trace mineral removal on pork products has not yet been determined; this is the topic of an experiment currently underway at Prairie Swine Centre.

Table 4. Effect of supplemental vitamin and trace mineral removal on carcass traits -sex effects

	Males			Females			P value		
	1	2	3	1	2	3	Treat.	Treat. x sex	Sex
Market wt., kg	111.8	109.0	111.6	103.9	104.6	103.8	ns	0.01	0.04
Dress wt., kg	92.2	90.3	92.3	89.1	88.2	89.8	ns	ns	0.01
Index	98.5	99.3	99.5	105.5	106.1	105.8	ns	ns	0.01
Yield, %	58.4	57.9	58.4	59.9	60.9	60.5	ns	0.06	0.01
Lean, mm	59.6	59.7	60.1	31.7	61.5	61.5	ns	ns	0.01
Fat, mm	24.6	25.3	24.1	20.2	19.2	19.9	ns	ns	0.01

[1]Basal diet (control)
[2]Basal diet with vitamins and trace mineral supplements removed for the final 3 weeks before expected marketing
[3]Basal diet with vitamins and trace mineral supplements removed for the final 5 weeks before expected marketing

Implications

Producers seeking to maximize net income are advised to reconsider the level of vitamin and trace mineral supplementation employed on their farm. Savings in the order of $1.00 per pig can be achieved by removing vitamins and trace minerals from their finishing diets for the final 5 weeks before marketing.

METHIONINE SOURCES FOR WEANLING PIGS

PREFERENCE OF WEANLING PIGS FOR DIETARY SUPPLEMENTAL METHIONINE SOURCES

Eduardo Beltranena, Raelene A. Petracek, Alison Bzowey, Harold Gonyou and John F. Patience

Summary

Along with the practice of earlier weaning, we have recently adopted the feeding of highly complex nursery diets. These commercial nursery diets contain high levels of spray-dried plasma and whole blood or blood cells. These rendering byproducts are known to be low in methionine. Thus, after lysine, methionine is the second limiting amino acid for weanling pigs in typical nursery diets presently. Although it has become customary to add supplemental methionine to nursery diets, questions remain as to which source of supplemental methionine should be used. Considering the importance of getting weanling pigs consuming dry feed as quickly as possible, and the benefits of weight gain during the nursery period on reducing days to market, it is important to determine if the different commercially available sources of methionine affect diet acceptance.

Three hundred and sixty pigs were involved in a nursery study to determine whether the dietary inclusion of DL-methionine reduces diet acceptance by weanling pigs and how other commercial sources of supplemental methionine compare.

During the first, third and fifth week following weaning at approximately 21 day of age, pigs were offered a choice between a basal diet (control) or the basal diet supplemented with DL-methionine, liquid methionine or liquid methionine hydroxy analogue (MHA), with or without a flavoring/aromatic agent. Daily feed disappearance was used as an indicator of diet preference.

The diet supplemented with DL-methionine was preferred by pigs over the control diet for the first three days following weaning. Both the DL-methionine and the liquid MHA supplemented diets were preferred for the last three days of the first week of the study. The dietary addition of DL-methionine, liquid methionine or liquid MHA increased the preference of pigs for these diets compared with the basal control diet during the entire third and fifth week. These results indicate no adverse effect of these supplemental methionine sources on the diet preference of nursery pigs.

The dietary addition of the flavouring/aromatic agent used in the present study reduced the preference of pigs for the treatment diets irrespective of the supplemental methionine source.

Experimental Procedure

The objective of this study was to determine whether the dietary inclusion of DL-methionine reduces diet acceptance by weanling pigs and how other commercial sources of supplemental methionine compare.

The trial was conducted in three all-in-all-out, identical nursery rooms. Each room was filled with pigs from one of three consecutive farrowing groups weaned at approximately 21 days of age. Within each weaning group, the pigs were weighed and sorted into two weight groups (light and heavy). Within each weight group, the pigs were randomly allocated, 10 pigs per pen, to one of six pens (twelve pens per room). Gender and litter of origin were balanced as much as possible. Then, the two pens across from each other in each room were paired together for the duration of the experiment. The treatment diets were randomly assigned to these pairs of pens.

Figure 1. Daily swapping of feeders among pens

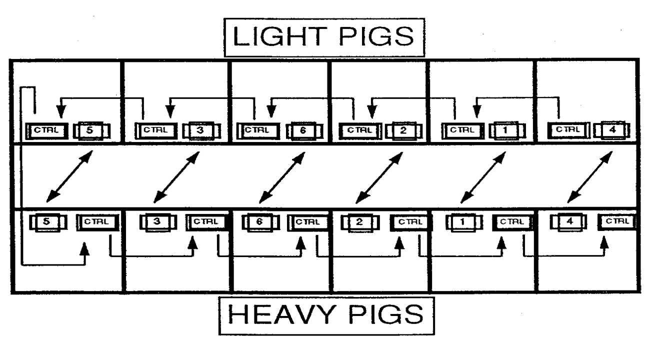

Table 1. Experimental diets

	Control	DL- Met	Liquid Meth.	Liquid MHA	DL- Meth. + + flavor	Liquid Meth. + flavor	Liquid MHA + flavor
Ingredients, %							
Corn	42.41	42.23	41.97	42.16	42.13	41.87	42.06
Soybean meal	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Spray-dried whey	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Dried skim milk	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Select menhaden meal	9.07	9.07	9.07	9.07	9.07	9.07	9.07
Canola oil	5.00	5.00	5.00	5.00	5.00	5.00	5.00
L-Lysine HCl	0.20	0.20	0.20	0.20	0.20	0.20	0.20
L-Tryptophan	0.045	0.045	0.045	0.045	0.045	0.045	0.045
L-Threonine	0.125	0.125	0.125	0.125	0.125	0.125	0.125
DL-Methionine 99.0%		0.177			0.177		
Liquid methionine 40.2%			0.435			0.435	
Liquid 88% MHA 70%				0.250			0.250
Limestone/glass rock	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mono/dical phosphate	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin premix[a]	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Trace mineral premix[b]	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Choline chloride 60%	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Flavor/aromatic agent					0.10	0.10	0.10
Medication	0.25	0.25	0.25	0.25	0.25	0.25	2.50
Calculated analysis							
DE, MJ/kg	15.03	14.98	14.94	14.98	14.98	14.94	14.94
Crude protein, %	20.62	20.78	20.75	20.77	20.77	20.75	20.76
Lysine -total, %	1.56	1.56	1.55	1.56	1.56	1.55	1.56
Methionine -total, %	0.42	0.60	0.60	0.60	0.60	0.60	0.60

[a] Provided the following per kg of premix: vitamin A 1,650,000 IU, vitamin D 165,000 IU, vitamin E 8,000, menadione 800 mg, thiamin 200 mg, riboflavin 1,000 mg, niacin 7,000 mg, d-pantothenic acid 3,000 mg, vitamin B12 5 mg, biotin 40 mg and folic acid 400 mg

[b] Provided the following per kg of premix: copper10 g, iron16 g, manganese 5 g, zinc 20 g, iodine 100 mg, selenium 20 mg

Daily feed disappearance was used as the indicator of diet preference. Daily feed disappearance was monitored only during weeks one, three and five following weaning. Two feeders were placed at the front of each pen providing the pigs with ad libitum access to feed. The feeder on the right side of the pen contained a common basal diet (control); the feeder on the left side of the pen contained one of the six treatment diets.

The feeders were adjusted to provide as similar a feed flow as possible. During each of the three test weeks, the feeders and the feed in them were individually weighed and rotated daily to reduce any variation in feed intake that may have occurred due to inequalities in feed flow in different feeders. The feeders containing the control diet rotated counter-clockwise around the room and the feeders containing the treatment diets were swapped back and forth across the room (Figure 1). Between test weeks (weeks two and four) the feeders were not rotated and all pigs were offered a commercial wheat-based starter diet. For each test week, pens were given a different choice than they had in any previous test week period.

Table 2. Daily feed disappearance(g) of diets containing different supplemental methionine sources with or without flavor compared with a basal control diet during the first three days following weaning of pigs at 21 days of age[a].

	Mean	Variance	*t* Stat[b,c]	% of total disappearance
Control vs.	32	1	4.37	25
DL-methionine	95	1		85
Control vs.	59	1	0.41	45
liquid methionine	71	1		55
Control vs.	67	3	0.20	48
liquid MHA	72	1		52
Control vs.	77	1	1.73	61
DL-methionine + Flavor	50	1		39
Control vs.	69	1	1.00	60
liquid methionine + Flavor	46	1		40
Control vs.	42	1	1.53	28
liquid MHA + Flavor	107	8		72

[a] 6 pens for each control vs. treatment diet; 10 pigs per pen
[b] Hypothesized mean difference = 0; *t* critical two-tail = 2.57 with μ = 0.05
[c] If the *t* Stat is greater than the t critical (2.57), pigs had a significant preference for the diet which mean is greater than the other in each pair

The test diets offered were (Table 1):

- Basal diet (corn, SBM, whey, skim milk, menhaden fishmeal)
- Basal diet + 0.177% DL-methionine (DL-2-amino-4-methylthio butanoic acid; 99%)
- Basal diet + 0.435% liquid methionine (aqueous solution of DL-2-amino-4- {methylmercapto}-butanoic acid sodium; 40.2%)
- Basal diet + 0.250% liquid methionine hydroxy analogue
- Basal diet + 0.177% DL-methionine (99%) + 0.1% flavor
- Basal diet + 0.435% liquid methionine (aqueous solution of DL-2-amino-4- {methylmercapto}-butanoic acid sodium; 40.2%) + 0.1% flavor
- Basal diet + 0.250% liquid methionine hydroxy analogue + 0.1% flavor

The basal diet was formulated to be adequate in methionine and total sulfur amino acids so that the response would not be due to the methionine requirement being satisfied.

The flavouring/aromatic agent used was one commonly used in nursery diets in Western Canada.

The pigs also had ad libitum access to water from two nipple drinkers located at the rear of each pen.

To determine whether or not a preference observed was apparent from the beginning or developed through the week as the pigs were offered the diets, each of the three test weeks were broken down into the first three days of the first week, the final three days of each test week (first, third and fifth) and the entire week (first, third and fifth). Each pen was identified as the experimental unit.

The feed disappearance data were analyzed in two ways: The first method involved subtracting the pen disappearance of the control diet from the disappearance of the treatment diet. The second involved expressing the disappearance of the treatment diet as a percentage of the total pen feed disappearance. The absolute differences and percentages were then ranked and analyzed statistically.

Results

Preference for the Supplemented Methionine Diets Versus the Control Diet

Table 2 shows the feed disappearance means for the first three days following weaning. Only the pigs offered the diet supplemented with DL-methionine, preferred it over the control diet. There was no preference for the liquid MHA or the liquid methionine diets over the control diet or for any of the supplemented diets added with the flavouring/aromatic agent over the control diet.

Table 3 shows the feed disappearance means for the entire first, third and fifth week following weaning. With the exception of the control vs. the liquid methionine diet for the first week, pigs preferred the supplemented diets over the control diet irrespective of methionine source. The same pattern of feed disappearance was observed during the last three days of the first, third and fifth week following weaning (data not shown).

The feed disappearance data summarized in Table 2 and 3 also indicated that when the three methionine supplemented diets were added with the flavouring/aromatic agent, pigs showed no difference in preference over the control diet during the first three days, the last three days of the first, third and fifth weeks or for the entire first, third and fifth weeks.

Conclusions

Given a choice, pigs preferred the diet supplemented with DL-methionine over the control diet for the first three days following weaning.

Both the DL-methionine and liquid MHA supplemented diets were preferred for the last three days of the first week. The dietary addition of DL-methionine, liquid methionine or liquid MHA increased the preference of pigs for these diets compared with the basal control diet during the entire third and fifth week. These results indicate no adverse effect of these supplemental methionine sources on the preference of nursery pigs.

The dietary addition of the flavouring/aromatic agent used in the present study , reduced the preference of pigs for the treatment diets irrespective of the supplemental methionine source.

Acknowledgment

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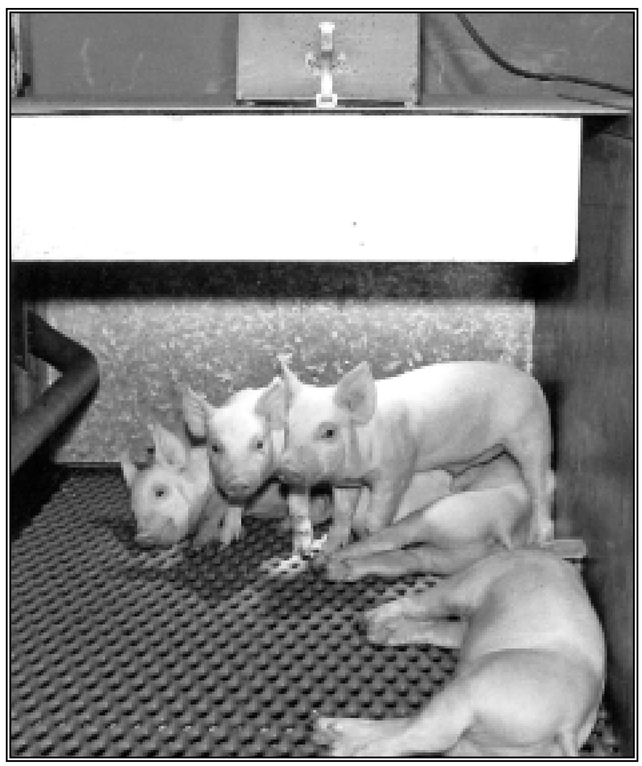

Farrowing crates feature a sliding cover in creep area

Table 3. Daily feed disappearance (g) of diets containing different supplemental methionine sources with or without flavor compared with a basal control diet during the first, third and fifth week following weaning of pigs at 21 days of age.

	1 - 7 d				15 - 21 d				29 - 34 d			
Pens, n/treatment	6				6				6			
Pigs, n	360				354				352			
	Mean	**Variance**	***t* Stat[a,b]**	**% of total disappearance**	**Mean**	**Variance**	***t* Stat[a,b]**	**% of total disappearance**	**Mean**	**Variance**	***t* Stat[a,b]**	**% of total disappearance**
Control vs.	66	0	4.07	32	234	7	3.20	33	420	18	3.55	37
DL-methionine	142	3		78	473	15		67	728	12		63
Control vs.	97	1	0.83	44	210	19	2.75	30	401	20	3.60	35
liquid methionine	121	3		56	480	14		70	748	12		65
Control vs.	88	3	2.94	41	228	9	5.42	31	491	16	2.88	41
liquid MHA	129	2		59	510	1		69	714	20		59
Control vs.	89	1	0.95	47	268	16	1.39	39	530	14	0.78	46
DL-methionine + Flavor	100	10		53	411	17		61	618	30		54
Control vs.	92	1	0.03	50	248	10	2.37	37	640	18	0.44	53
liquid methionine + Flavor	91	2		50	417	9		63	579	47		47
Control vs.	70	1	1.83	31	343	2	0.59	52	746	28	2.55	63
liquid MHA + Flavor	156	11		69	311	11		48	438	17		37

[a] Hypothesized mean difference = 0; *t* critical two-tail = 2.57 with μ = 0.05

[b] If the *t* Stat is greater than the t critical (2.57), pigs had a significant preference for the diet which mean is greater than the other in each pair

MANAGING PIG SPACE: FEEDER POSITION AND ORIENTATION

Managing Pig Space: Feeder Position and Orientation

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Summary

Movement is a major and defining aspect of animal life. Animals are distinct from plants in that they move about within their environment, and this ability gives them a quality that we often refer to as behaviour. If an animal is hungry, it is motivated to move and search for food. The requirement animals have for space is that which is needed to accommodate this movement.

Space requirements are usually defined in terms of quantity. Often these requirements are given as units of area per animal, or in relation to body weight. Space can also differ in terms of quality. Quality may involve the shape of the space provided, or the location of resources within that space. High quality space accommodates the behaviour of the animals in relatively small amounts of area. Poor quality space only accommodates the behaviour of animals if large amounts of space are provided.

This report relates to a series of experiments we have conducted in which space has been modified by the position and orientation of feeders within a standard pen. Both the behaviour and the productivity of the animals have been studied. The goals of the research include both an evaluation of currently available pen and feeder configurations, as well as developing a model which predicts behaviour in novel conditions. The long- term goal is to address practical barn design problems using computer modelling rather than trial and error.

This series of experiments identifies the fact that feeders should be positioned such that pigs enter from the sleeping area, rather than from the back of the pen.

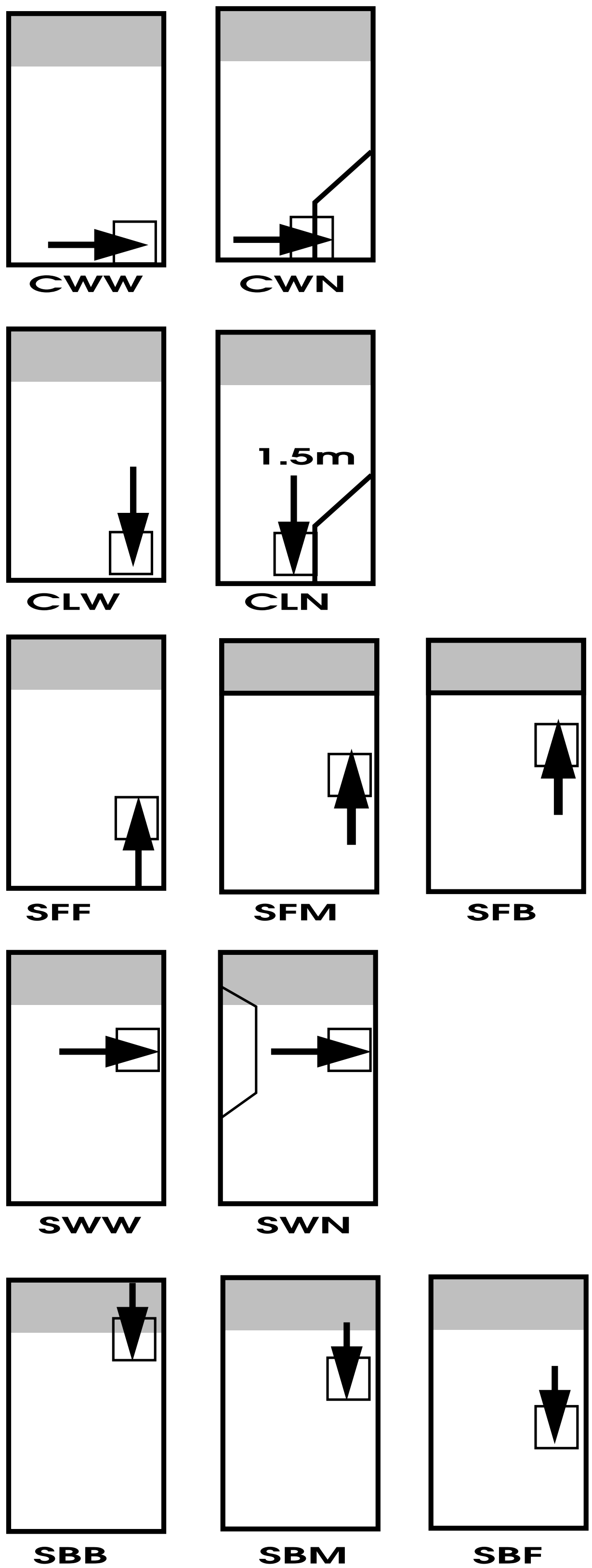
Experiment 1

Twelve configurations of feeder position and orientation were evaluated in partially slatted pens [4.2 x 2 m (16′ x 7′), 1/3 slatted]. Pen partitions were solid concrete over the solid floor, and slatted concrete over the slatted area. Pens were arranged in two rows of six, separated by a slatted concrete wall at the slatted end of the pens. The end wall opening into the perimeter alley of the room was solid, comprised of polycarbonate planking.

The feeder positions and orientations were as follows:

- corner, width, wide: feeder in front corner of pen, oriented so that pigs stand along front wall while eating, normal width of pen (CWW)
- corner, width, narrow: similar to CWW but pen narrowed by .5 m in feeding area (CWN)
- corner, length, wide: feeder in front corner of pen, oriented so that pigs stand along side wall while eating, normal width of pen (CLW)
- corner, length, narrow: similar to CLW but pen narrowed by .5 m in feeding area (CLN)
- side, width, wide: feeder mid-way along side of pen, oriented so pig stands across width of pen to eat, normal width of pen (SWW)
- side, width, narrow: similar to SWW but pen narrowed by .5 m in feeding area (SWN)
- side, front, front: feeder along side of pen, oriented so pig stands along wall while eating, enters the feeder from the front of the pen, near front of pen (SFF)
- side, front, middle: similar to SFF but positioned mid-way back the side of the pen (SFM)
- side, front, back: similar to SFF but positioned near the back of the pen (SFB)
- side, back, front: similar to SFF but oriented so that pig enters the feeder from the back of the pen (SBF)
- side, back, middle: similar to SBF but feeder located mid-way back the side of the pen (SBM)
- side, back, back: similar to SBF but feeder located near the back of the pen (SBB)

Figure 1: Position and orientation of feeders for experimental treatments. Shaded area represents slatted portion of the pen floor.



Ten pigs were housed in each pen. Pens were re-configured every 3 weeks (period) so that each pen of animals was exposed to 4 position and orientation combinations. Two weeks of growth and intake data, and 10 days of dunging patterns were collected each period. Dunging scores were collected for the front, middle and back thirds of the pen. Low dunging scores reflect clean areas, while higher scores were considered unsuitable for lying. The animals were video-taped for 24 hours during each period. The tapes were analysed for general activity, eating and drinking.

Experiment 2:

Three feeder position and orientation configurations (CLW, SFM and SBM), were included in the second study. These were selected based on the low (favourable) dunging scores attained in Experiment #1. Each room of 12 pens included 4 pens of each treatment. Three rooms were run during the winter, and an additional two rooms run during the summer. Gain and feed intake were determined at 4 week intervals for 12 weeks. Dunging patterns were recorded for 5 days at the end of each 4-wk period.

Experiment 3:

An animat is an automated (synthetic) animal; either a computer simulated animal or a robot. In this study we used computer simulations of pigs to evaluate five of the position and orientation configurations of feeders studied previously (CWW, CLW, SWW, SFM and SBM). In the first study, each animat was programmed with the motivation to eat, and could move around the simulated pen to satisfy its motivation. Motivation increased at intervals until a threshold was reached, at which point the animal stood, approached the feeder, and satisfied its motivation. The motivation level for that behaviour was reduced to zero, the animal would lie down, and motivation began to accumulate again. In the second study, the motivation to drink was added to each animat.

The simulation involved 10 animats per pen. One hundred fifty pens were run for each pen configuration. Two types of encounters between animats were recorded; the first was interference during movement towards a resource, the second was interference due to crowding around a resource.

Table 1. Dunging patterns of pigs in pens with different combinations of feeder position and orientation (Expt. 1).

Position and Orientation[a]			Dunging Location: Front			Middle			Back	
Corner	Width	Wide	1.04			1.34			2.97	
				1.07			1.39			3.10
Corner	Width	Narrow	1.10			1.44			3.22	
					1.09			1.38		
Corner	Length	Wide	1.18			1.43			2.96	
				1.11			1.36			3.04
Corner	Length	Narrow	1.03			1.30			3.11	
Side	Width	Wide	1.17			1.41			2.91	
				1.19			1.36			2.93
Side	Width	Narrow	1.21			1.31			2.95	
Side	Front	Front	1.06			1.34			3.00	
Side	Front	Middle	1.03	1.06[b]		1.24	1.25[b]		3.28	3.12
Side	Front	Back	1.08			1.18			3.07	
Side	Back	Front	1.19			1.52			2.65[b]	
Side	Back	Middle	1.24	1.20[c]		1.32	1.41[c]		2.92[c]	
Side	Back	Back	1.18			1.38			3.03[c]	
		s.e.	.069			.091			.163	

[a] Feeders positioned in the front corner or along side of pen. Pigs stand across the width or along length of pen, entering from the front or back of pen. Pens were wide or artificially narrowed, and feeders along the side were near the front, middle or back of pen.

[b,c] Means within columns with different superscripts differed (p>.05).

Table 2. Preliminary data[a] on the behaviour of pigs in pens with different feeder positions and orientations

Activity per pig			Orientation and Position: Corner Width Wide	Corner Length Wide	Side Width Wide	Side Front Middle	Side Back Middle
Activity bouts/day	(#)	28.4	58.8	42.0	50.4	50.0	
Non-eating activity duration/day	(min)	115	273	117	166	148	
Eating bouts/day	(#)	13.2	13.3	14.4	17.7	20.2	
Eating duration/day	(min)	34.2	41.8	46.9	64.8	58.6	
Drinking bouts/day	(#)	14.0	21.8	20.0	20.8	17.2	
Zones travelled/day	(#)	343	512	265	423	354	

[a] These data represent only one pen per treatment, observed for one day. The intention is to represent the types of data being analyzed, and no treatment comparisons should be made.

Table 3. Dunging patterns of pigs in pens with different feeder positions and orientations (Expt.2)

Period	Position and Orientation		Winter			Summer		
			Front	Middle	Back	Front	Middle	Back
0-4 wks	Corner	Length	1.31	1.32	3.19[ab]	1.59[a]	1.89[a]	1.80
	Side	Front	1.03	1.15	3.36[b]	2.50[b]	2.49[b]	1.63
	Side	Back	1.14	1.35	3.16[a]	2.50[b]	2.50[b]	1.64
5-8wks	Corner	Length	1.32	1.29	3.32[a]	2.09[a]	2.40[a]	2.66
	Side	Front	1.08	1.12	3.58[b]	2.96[b]	2.99[ab]	2.63
	Side	Back	1.11	1.22	3.29[a]	3.12[b]	3.19[b]	2.78
9-12 wks	Corner	Length	1.25	1.27	3.35	1.23	1.55	3.06
	Side	Front	1.27	1.22	3.44	1.25	1.58	3.05
	Side	Back	1.25	1.33	3.43	1.21	1.70	2.78

[a,b] Means within periods within columns with different superscripts differ (P>.05).

Results

Experiment 1: The dunging patterns of pigs are presented in Table 1. The front and middle thirds of the pens were notably cleaner than the slatted area. The best dunging patterns were observed in pens with feeders positioned along the side of the pen, with pigs entering from the front of the pen. The worst dunging patterns were observed in pens in which pigs entered the feeder from the back of the pen. Corner positions and side positions with pigs eating while standing along the width of the pen were intermediate.

Few differences were evident in gain and intake among the configurations. Intake was reduced when the pen was narrowed and the feeder was along the side (2.41 vs 2.30 kg/day for SWW and SWN, respectively; P<.05). Similar trends were evident for narrowed pens with feeders in the corner. Although our hypothesis is that interference in the vicinity of feeders in these narrowed pens caused this reduction in intake, it may be that the reduction in total space allowance in these treatments contributed to the poorer performance.

Preliminary results of the behaviour analysis are presented in Table 2. Because only one pen has been analysed per treatment to this point, comparisons must be limited. However, the number of eating and drinking bouts per pig are similar to reported values. Total duration of eating seems low, but this data represents the period when the pigs were quite small. The tendency for feeder positions along the side to result in greater eating durations may be significant if it continues with older pigs.

Experiment 2: The dunging patterns of pigs in the five configurations are presented in Table 3. Dunging patterns during the winter were very similar to those in Experiment 1. Although not reaching a significant level, the tendency was for better dunging scores in pens in which pigs entered the feeder from the sleeping area (CLW and SFM). Dunging scores during the summer were unsatisfactory as higher scores were obtained in the front two thirds of the pen than over the slats during the first two periods. During these periods the best scores were obtained in pens with a corner location for the feeder. Having access to the feeder from the lying area appears to be the most favourable in terms of dunging patterns, in both summer and winter.
Gain, feed intake and feed efficiency did not differ among the three configurations. The number of pens studied in this experiment allows for a great deal of confidence in these production results. It would appear that pigs are quite able to adapt to differing pen configurations within the scope of this experiment.

Experiment 3: The animat simulation represents an early step in the application of behaviour modelling to facility design. The detailed behaviour data collected in Experiments #1 and #2 plus knowledge from previous studies can be combined in this way to facilitate how the pig might react given our current level of knowledge. Interference during movement was reduced when resources were placed far apart. Interference in the vicinity of the resources was greater when pigs ate while standing in the middle of the pen (SWW). When only eating was considered, interference in the vicinity of resources was greater with corner feeders than with feeders along the side of the pen. However, when both eating and drinking were included, the proximity of the drinker to the feeder resulted in greater interference with side positioned feeders. The behaviour of animats used in this simulation will be adjusted to better reflect that of actual pigs in similar conditions (Experiment 1). As greater confidence is developed in the simulation process, a wider range of pen configurations will be evaluated using animats prior to animal studies.

Conclusions:

Traditional studies of space requirements for animals provide answers to very practical questions but provide little theoretical basis for extrapolation to non-conventional pen configurations. The results of this series of experiments demonstrate that pigs are able to adapt to different feeder position and orientation configurations and maintain feed intake and gain. There is evidence that other production considerations, such as cleanliness of the pen, do differ among configurations. Feeders should be positioned such that pigs enter from the sleeping area, rather than from the back of the pen. However, dunging patterns are affected more by season than by the differences in pen configuration studied here. The preliminary observations on pigs, and the results of animat simulations, suggest that behaviour is likely to vary among the configurations studied. The point at which behavioural adaptation can no longer maintain productivity was not reached in this study. However, some aspects of pen design, such as distance between resources, required considerable behavioural adaptation and may be stressful in more extreme conditions.

7′ x 16′ partially slatted grower-finisher pens

STEREOTYPIC BEHAVIORS IN SOWS

NUTRITIONAL FACTORS INVOLVED IN THE DEVELOPMENT OF STEREOTYPIES IN SOWS HOUSED IN INDIVIDUAL STALLS

Renée Bergeron and Harold Gonyou

Summary

Pregnant sows housed in modern production facilities often develop abnormal behaviors called stereotypies. These behaviors are characterized as regularly repeated movements that are morphologically identical and apparently useless. In sows these usually consist of oral movements such as biting and chewing directed at different parts of the animal's environment. For instance, sows may spend several hours biting the bars of their stall, chewing on a chain, vacuum chewing (chewing with an empty mouth) or drinking excessively. Researchers have observed sows performing stereotypies for more than 70% of the time. The importance of such behaviors is that they increase energy expenditure. More important, stereotypies are a welfare concern because they are perceived to reflect inadequacies in the production system.

Food restriction is thought to be a major factor involved in the development of stereotypies. Several experiments have demonstrated that increasing the animal's food allowance decreases the performance of stereotypies. Furthermore, stereotypies in restricted-fed animals are mainly observed around feeding time, and these often involve oral movements such as chewing and biting, which are related to feeding behaviors. These studies also suggested that the development of stereotypic behavior is related to the persistence of a high feeding motivation after feeding.

The objective of the following experiments was to evaluate the relative role of two consequences of food restriction on the development of stereotypies in pregnant sows: The first is the lack of energy, which results in hunger, and the second is the lack of foraging substrate, which may prevent the expression of foraging behaviors. Previous experiments successful at reducing stereotypies involved increasing food allowance, providing straw as a foraging substrate, and increasing the bulk of the ration by adding a fibrous ingredient to the diet. None of these experiments, however, were designed to evaluate the relative importance of energy and foraging substrate in the development of stereotypies.

Experiment 1

In this study, we tried to evaluate the impact of artificially decreasing hunger without increasing meal size on the persistence of feeding motivation and the development of stereotypies in the after feeding period. This study was carried out in two stages.
In the first stage, several treatments thought to reduce hunger were applied to 12 gilts after feeding, in order to identify a means of decreasing their motivation to eat without offering them more food. The treatments were as follow:

- A naloxone injection (1mg/kg of body weight) which has been reported to decrease feed intake in rats and pigs.
- Two liters of water, containing 40% sugar, offered before the meal, which distends the intestine and reduces intake.
- A 60-min cholecystokinin infusion (0.167 mg) into the ear vein. Cholecystokinin is a small protein secreted in the small intestine which is known to trigger a satiety sensation.

A conditioning technique was used to measure the gilts' feeding motivation. They were previously trained to press a panel 20 times to obtain small food rewards. The number of rewards obtained in a 60-minute period starting 30 minutes after feed delivery, was used as a measure of feeding motivation.

In the second stage of this study, the same treatments were applied to 10 second-parity sows in the after feeding period to measure the treatment effects on the development of stereotypies. The sows were taped using a video camera and continuous behavioral observations were made for 90 minutes starting 30 minutes after feed delivery.

Results

For the first stage of the study, we concluded that attempting to reduce feeding motivation over a short period of time in restricted-fed animals is very difficult. The infusion of cholecystokinin was the only treatment capable of reducing the gilts' responses for food, thus reflecting a lower feeding motivation.

For the second stage of the study, sows infused with cholecystokinin also showed behavioral changes indicative of satiety. These changes were mainly reflected by an increased proportion of time lying inactive. However, the cholecystokinin infusion failed to reduce the performance of repetitive behaviors in treated sows. Consequently, this experiment did not provide any support for the hypothesis that decreasing feeding motivation over a short period of time following the normal meal may prevent the development of stereotypic behavior.

Table 1. Effect of a control diet, a "high-energy" diet and a "high-foraging" feeding system on the percentage of observations spent in various postures and activities by sows

	Control	High energy diet	High foraging	SE
Number of sows	8	8	8	
AFTER FEEDING PERIOD				
Posture				
Lying down	33.33[b]	41.36[a]	26.48[c]	2.27
Standing	61.67	55.51	66.67	2.20
Activity				
Chain manipulating	38.28	22.44	41.62	1.84
Vacuum chewing	14.39[a]	5.73[b]	3.99[b]	1.04
Inactive	17.88[c]	39.37[a]	27.91[b]	2.22
AFTERNOON PERIOD				
Posture				
Lying down	88.50	82.81	72.43	2.09
Standing	10.60	14.28	26.34	2.01
Activity				
Chain manipulating	8.04	8.82	18.64	1.44
Vacuum chewing	5.13	1.34	2.57	.87
Inactive	84.15	85.04	75.33	1.79

[a,b,c] Means in a row with different superscript letters differ ($P < 0.05$)

Experiment 2

This study was conducted over an 8-wk period of time. The objective was to evaluate the relative role of a lack of energy and a lack of foraging substrate in the development of stereotypies in sows. Twenty-four second-parity sows in their eighth week of gestation were classified into four categories according to their activity level (category 1; most active; category 4, least active). The activity level was determined by calculating the proportion of observation time (180 min) a sow was active. Sows within each group were randomly assigned to one of three treatments:

- Sows were offered a control diet which provided the level of energy recommended by NRC, based on body weight. Sows were offered a high-energy diet. This diet provided 1.7 times more energy, but identical weight as the control diet.
- Sows were submitted to a high-foraging treatment. This consisted of a device placed inside the feeder for one hour at meal time to increase feeding time. The device consisted of a metal frame holding a set of 8 parallel chains which hung into the feed bowl. These sows were fed the control diet, at standard levels.

Each treatment provided a similar volume of food. The animals were housed in gestation stalls and had free access to water all the time, provided from individual nipple drinkers. The sows' individual stalls were also fitted with a chain to facilitate the development of stereotypic behaviors. To evaluate the treatment effects on stereotypic behaviors, observations were made once a week by scan sampling for 8 consecutive weeks. The behavior of each sow was recorded at 3 min intervals from 8:45 until 10:45, and at 15 min intervals from 10:45 to 15:45.

Results

We observed that the sows offered the high-energy diet spent a larger percentage of time lying inactive after feeding; this behavior was indicative of satiety ($P < .05$; Table 1). These sows also showed a trend towards a reduced percentage of time spent manipulating the chain; almost 50% compared with control sows. Sows offered the high energy diet also tended to reduce vacuum chewing in the after feeding period. These observations suggest a possible preventative effect of the high energy diet on the development of stereotypies. In fact, none of the sows offered the high-energy diet became stereotypic during the experiment.

Table2. The influence of initial activity level on the percentage of observations spent in various postures and activities of sows.

	Activity level: More active ⟵			⟶ Less active	SE
Number of sows	**6**	**6**	**6**	**6**	
After feeding period					
Posture					
Lying down	8.56[c]	34.55[b]	38.14[b]	53.64[a]	2.63
Standing	89.24[a]	60.07[b]	58.51[b]	37.33[c]	2.54
Activity					
Chain manipulating	55.21	30.67	29.22	21.35	2.11
Vacuum chewing	1.74	11.92	13.14	5.32	1.14
Inactive	9.95[c]	29.11[b]	27.26[b]	47.22[a]	2.52
Afternoon period					
Posture					
Lying down	63.99[b]	86.46[b]	86.16[b]	88.39[a]	2.40
Standing	32.74[a]	12.05[b]	13.39[b]	10.12[b]	2.34
Activity					
Chain manipulating	24.70	9.08	9.52	4.02	1.66
Vacuum chewing	1.04	5.21	3.42	2.38	1.00
Inactive	68.15[c]	83.04[b]	84.82[b]	90.03[a]	2.11

[a,b,c] Means in a row with different superscript letters differ ($P < 0.05$)

Providing sows with more opportunity to perform foraging behaviors by the use of the special feeding device increasing feeding time, did not consistently affect repetitive behaviors. Vacuum chewing was reduced in these sows during the after feeding period compared with control sows. However, these sows tended (P<.10) to manipulate the chain more during the afternoon period. The fact that two sows on this treatment were showing stereotypies at the end of the experiment at a level similar to the control group, did not provide much support for the hypothesis that a behavioral need to forage may be a causative factor in the development of stereotypies. It should be noted that chains were used to increase foraging and as a substrate for stereotypies in this study. Alternative means of increasing foraging should be studied in the future.

For both the post-feeding and the afternoon observation periods, sows that had been initially classified as most active, were also the most active throughout the experiment (Table 2). These sows spent more than twice as much time manipulating the chain as sows in other less active categories. It seems that an animal's tendency to be more active facilitates the development of stereotypies. Furthermore, sows in the most active category also gained less weight than sows in any other group. Because a large proportion of their active time was devoted to chain manipulation, this reduction in weight gain is in accordance with previous findings that high stereotypic sows produce more heat and consequently retain less energy compared with low stereotypic sows.

Conclusion

Our results suggest that the long-term satiety induced by an increased energy level in the diet has the potential to reduce the incidence of repetitive oral behaviors such as chain manipulating and sham chewing. However, providing more opportunity to forage at meal time without increasing meal size does not seem to consistently affect repetitive oral behaviors. A lack of energy may therefore play a more important role in the development of stereotypies, than a lack of foraging substrate around meal time. Stereotypies signal an inadequacy in the environment, and in the case of gestating sows, this appears to be an inadequate energy supply to prevent hunger. In addition, performance of stereotypies is energy demanding, resulting in reduced weight gains during pregnancy. Based on these results, future research directed to reducing stereotypies should focus on developing feeding methods which reduce hunger in pregnant sows.

Sow manipulating a chain in dry sow crate

DEVELOPMENT OF AN AERODYNAMIC DEDUSTER FOR LIVESTOCK BUILDINGS

G.A. Zhao, Y. Zhang

Summary

Dust is among the major pollutants that have a detrimental effect on the health of pigs and persons working in swine barns. Dust particles vary in size. Heavy particles settle out quickly, however, light particles remain suspended in the barn air representing a more significant threat to people and animals that inhale them. In this study, we designed and tested an aerodynamic deduster prototype that could be affixed to a recirculation duct. We also developed a particle separation theory to test the prototype based on the analysis of particle size.

Factors that affected particle separation efficiency in the aerodynamic deduster included the deduster's configuration, dust particle size and the air flow condition in the deduster. For example, the dust separation efficiency was 10% to 20% for particles of 2 μm and 30% to 37% for particles of 5 μm.

Further research is needed to evaluate the effect of several factors on dust separation efficiency. These factors include air velocity through the deduster, the length and width of various sections of the deduster, and turbulence intensity created in the vortex chamber.

Introduction

A number of mechanical methods for dust control have been considered. These methods included fiber filters, water or oil scrubbers, electrostatic precipitators and cyclone type aerodynamic dedusters. Most of these methods need to be associated with the ventilation system in the barns, and require large quantities of air flow to pass through the equipment. Many of these devices have been of limited use in swine buildings because in their association with the ventilation systems, they reduce the performance of the ventilation system, require high power, or have a high maintenance cost.

Aerodynamic dedusters are mainly of two types: one is the returned-flow and the other is the uniflow type. The working principle for the aerodynamic deduster is that as the air is dragged through, a centrifugal force is applied against the drag force (Figure 1). This forces the particles to separate from the main air stream and to accumulate in a chamber. The advantages of using aerodynamic dedusters are they are easy to install and operate, have low initial and operating costs, and have the capability of handling large quantity of recirculated dusty air, and to a certain extent, these devices are self-adjusting. These advantages are especially important in their applications for livestock buildings where high dust concentration and high ventilation (or air recirculation) are common.

Previous studies concluded that aerodynamic dedusters could not separate particles smaller than 10 μm, and therefore, were not applicable for livestock buildings. These conclusions were made on the basis of the specific designs and experimental conditions in which those devices were tested. However, if the air flow patterns within the deduster chamber are changed by modifying the configuration of the aerodynamic deduster, in theory, a smaller particle size range can be separated and the dust separation efficiency can be improved.

The objectives of this project were: Firstly, to develop a particle separation theory to predict particle cut-size and dust separation efficiency. Secondly, to design and construct an aerodynamic deduster based on the analysis of the theory and the ventilation requirement in swine buildings. And thirdly, to test such an aerodynamic deduster based on its dust separation efficiency.

Design and Installation

The analysis of dust particle size and dust separation efficiency is based on the sketch of the uniflow deduster shown in Figure 1. The rationale of using the uniflow principle is based on the following: First, this type of aerodynamic deduster appears more applicable than a returned-flow type of deduster for livestock buildings. Second, it has been suggested that very fine dust (< 2.6 μm) could be separated if the laminar flow pattern was achieved in the vortex chamber (In laminar flow, fluid particles move along smooth paths in layers, with one layer gliding smoothly over an adjacent layer.). And third, the laminar flow condition is more easily achieved in the uniflow type of aerodynamic deduster than in the returned-flow type of aerodynamic deduster.

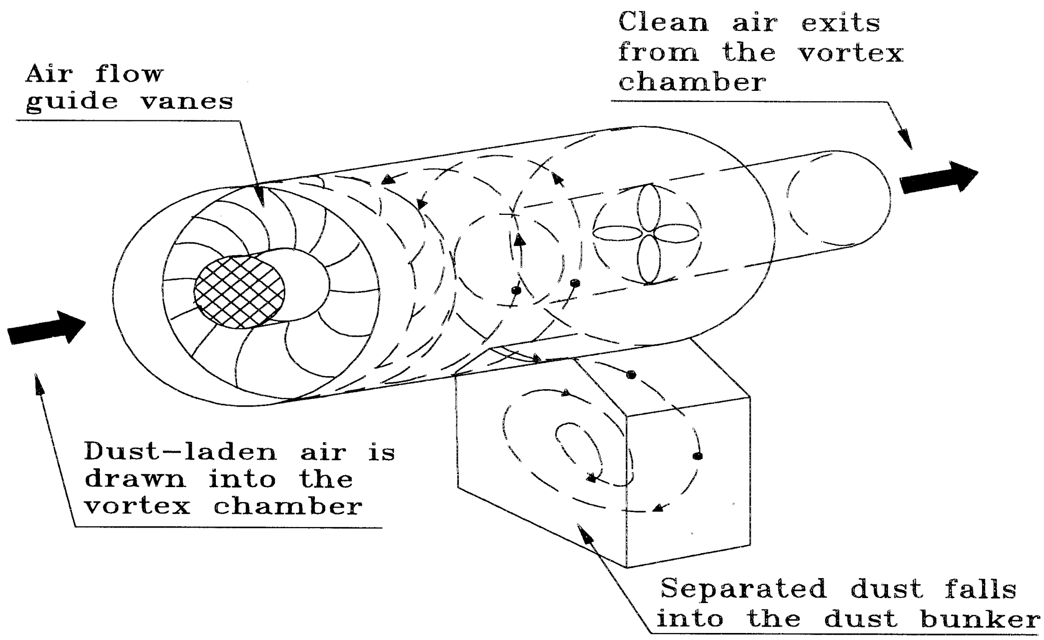


Figure 1. A sketch of the uniflow aerodynamic deduster prototype

Dust-laden air enters the separation chamber through angled vanes. The air flow pass is in a spiral shape. Thus, particles heavier than the air are then separated from the air stream and eventually collected in a dust bunker. The cleaned air exits through the outlet (Figure 1).

Specification

Specific considerations in the design of this uniflow aerodynamic deduster were (Figure 1 and 2):

1 Pressure drop across the deduster should be minimized.
2 Within the allowance of the space, length of the deduster should be as long as possible to achieve smaller particle cut-size and higher dust separation efficiency.
3 The angle of the vanes with respect to vertical plane should be as small as possible to produce high initial rotational air velocity.
4 The difference between R_1 and R_2 (Figure 4) should be as small as possible so that turbulence intensity can be minimized in the vortex chamber.

Experimental Room and Environment

The deduster was tested in a 11 x 6 m≤ nursery room at Prairie Swine Center. The room has 13 elevated pens with tenderfoot flooring. Each pen housed 5 to 7 piglets during the length of testing period. Piglets were offered crumbled diets from a self-feeder located at the front of the pen. Self-feeders were filled by hand approximately once a day. The room was ventilated under negative pressure using a variable exhaust fan and heated using a gas heater. Fresh air entered the room from the ceiling air inlet and mixed with room air with assistance of a recirculation system consisting of a duct and a fan. The recirculation system drew room air through the deduster and distributed the air to the room through a series of small holes along the duct. During the testing period, the room was maintained at temperatures between 23 to 28 ^{0}C depending on the pigs' weight.

The deduster was attached up-stream of the recirculation fan, which was used as the power unit for the deduster (Figure 2). By locating the deduster upstream of the fan, turbulence intensity in the deduster chamber could be reduced and particle separation efficiency could be improved. Due to the limitation of room size, the deduster was installed perpendicular to the recirculation duct. The effect of the elbow connecting the deduster and the recirculation duct on airflow in the deduster chamber was negligible because the elbow was the downstream side of the fan.

Figure 2. Location of the aerodynamic deduster in the room. Floor plan showing location of deduster

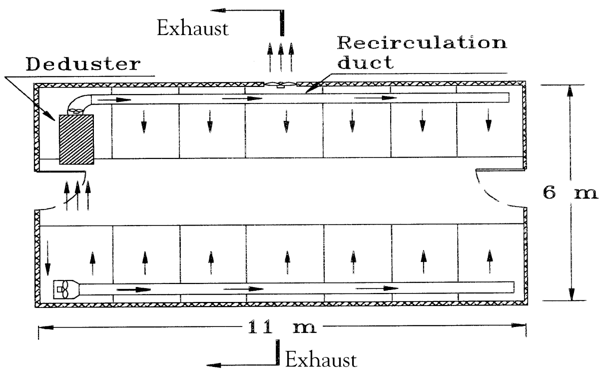
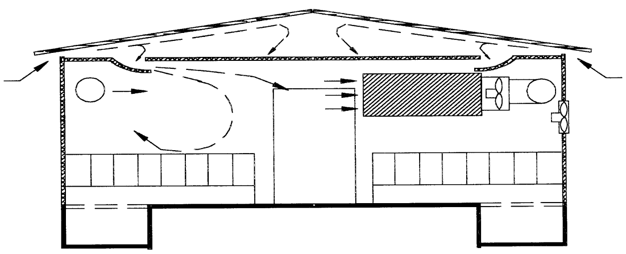


Figure 3. Air flow in the nursery room

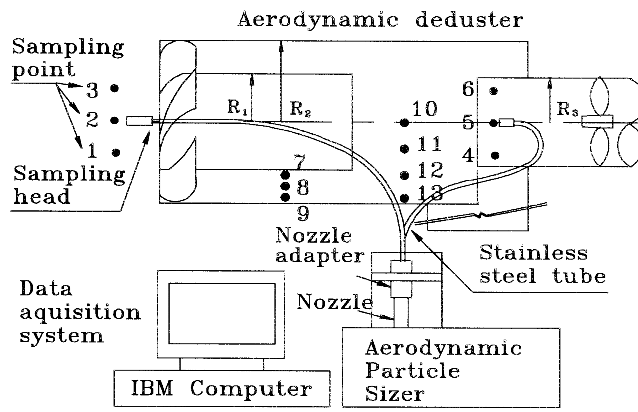


A–A Section view of the deduster location

Measurements and Data Acquisition

An Aerodynamic Particle Sizer (APS, Model 3310A, TSI Inc.) was used to measure dust concentration with respect to particle diameter ranging from 0.5 to 30 μm. Dust concentrations up- and down-stream of the deduster were measured to calculate the dust separation efficiency. Two stainless steel tubes with the same length and diameter were used to extend the Aerodynamic Particle Sizer inlet nozzle to the points of dust measurement (Figure 4). The measured points were evenly and symmetrically paired 1 and 4, 2 and 5, and 3 and 6 along the vertical diameters of the inlet and outlet of the deduster. An adapter was made to manually shift and connect tubes with the nozzle of the Aerodynamic Particle Sizer. Four sampling heads were designed to ensure the same air velocity sampling before and after the deduster. At each point, dust concentrations were measured at three levels of average rotational air velocity, 1, 3, and 6 m/s in the vortex chamber. At each air velocity, five replications were conducted. In total 90 measurements were taken (6 points x 3 air velocities x 5 replications).

Figure 4. Sites at which experimental measurements were taken



The drop in air velocity and pressure were measured using a hot wire anemometer. Air velocity was measured at all points shown in Figure 4 (numbered 1 to 13). Total pressure drop across the deduster was measured at points numbered 4, 5 and 6.

Results and Discussion

Although particles from 0.5 to 30   were measured using the Aerodynamic Particle Sizer, only particle sizes ranging between 0.5 to 15   were considered. The reasons for this are, first, that small particles are the main health concerns for human and animal. And second, sampling efficiency of the Aerodynamic Particle Sizer decreases as particle size increases.

Figure 5 shows the dust concentration measured upstream and downstream of the aerodynamic deduster at the rotational air velocity 1, 3, and 6 m/s, respectively. Each point in Figure 5 is the mean value of 15 measurements (3 points x 5 replications).

Dust separation efficiency was calculated as:

$$\eta = \frac{C_{up} - C_{down}}{C_{up}} \cdot 100\%$$

Where

- C_{up} is the dust concentration at up-stream of the deduster, count/mL
- C_{down} is the dust concentration at down-stream of the deduster, count/mL.

Figure 5a

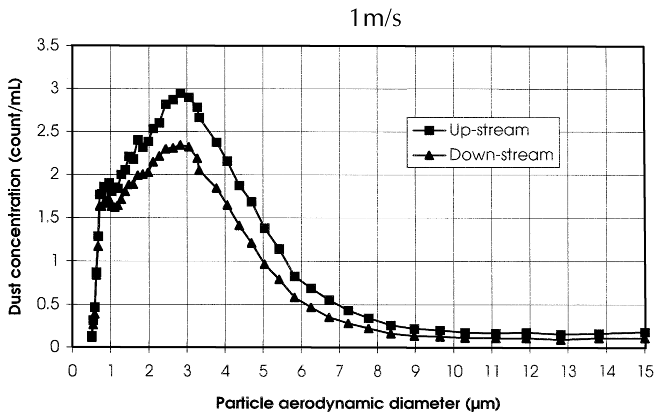


Figure 5b

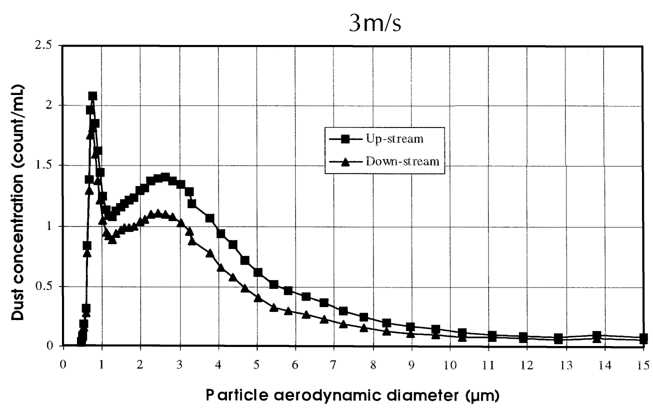


Figure 5c

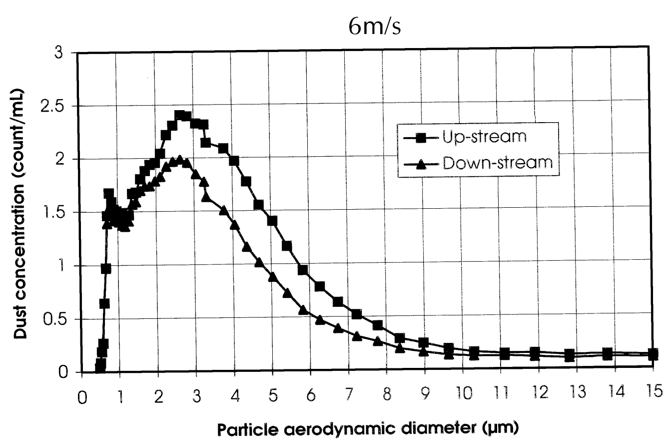


Figure 6 shows the calculated results of dust separation efficiency. Dust separation efficiency increased for particles ranging from 1.5 μm to 6 μm at the three air flow speeds measured. For example, separation efficiency was 10% to 20% for particles of 2 μm and 30% to 37% for particles of 5 μm diameter. Dust separation efficiency appeared unstable for particles larger than 6 and 10 μm

$(\overline{V}_{\theta 1} = 3.0, \text{and } 6.0\, m/s, ; \qquad \overline{V}_{\theta 1} = 1.0\, m/s,$

respectively). For particles larger than 5 μm, the sampling efficiency of Aerodynamic Particle Sizer decreased as particle size increased. This decreasing dust sampling efficiency resulted in lower dust concentration measurements. The sampling efficiency of the Aerodynamic Particle Sizer is not discussed in this article.

For the particles smaller than 1 μm, the dust separation efficiency fluctuated widely. This is considered to be due to the background dust concentration. The background dust from incoming air is primarily composed of small particles (smaller than 1μm).

Conclusions

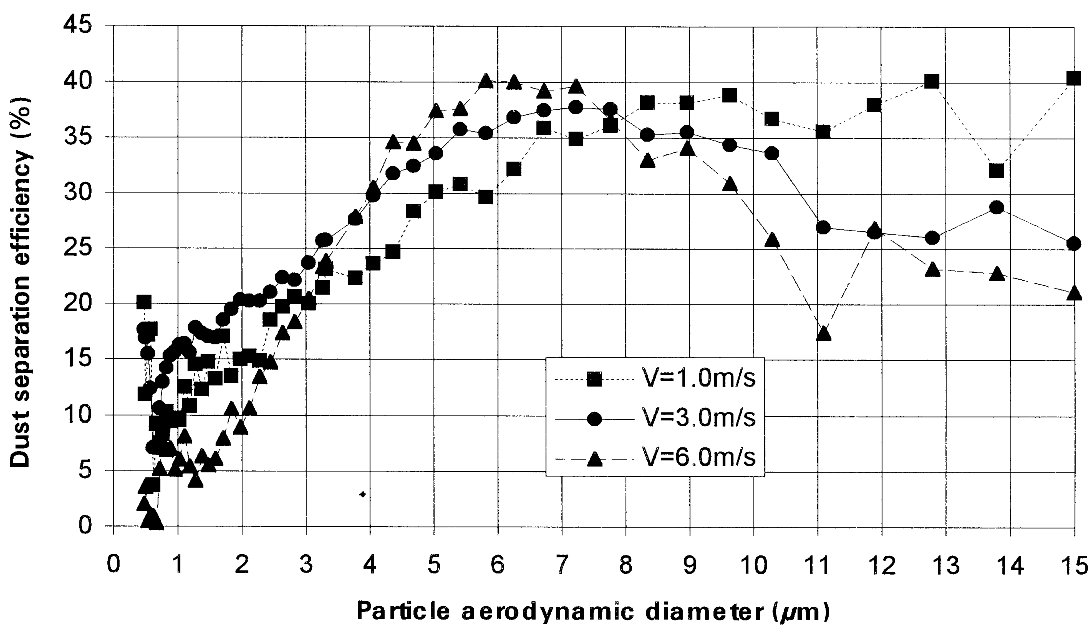
A particle separation theory for the uniflow aerodynamic deduster was modified and a prototype of the aerodynamic deduster was designed and tested based on the analysis of the particle separation. Factors affecting particle separation efficiency included the aerodynamic deduster design, particle size and air flow condition in the deduster. The dust separation efficiency was 10% to 20% for particles of 2 μm and 30% to 37% for particles of 5 μm.

Further research is needed to evaluate the effect of several factors on the dust separation efficiency. These factors include air velocity through the deduster, the length of the vortex chamber, the radius ratio of R2 to R1 (inside chamber radius to outside chamber radius) and R3 to R1 (outlet radius to insider chamber radius) and turbulence intensity in the vortex chamber.

Acknowledgment

The authors acknowledge the financial supports from the National Science and Engineering Research Council (NSERC) of Canada and the Alberta Agricultural Research Institute (AARI). The authors also wish to extend thanks to Dr. E. M. Barber for his advice during the project. Technical supports from Mr. L. Roth and Prairie Swine Centre staff are appreciated.

Figure 6. Dust separation efficiency of the deduster at three different tangential air velocities in Section 1 of the deduster



SPRINKLING CANOLA OIL IN BARN ROOMS

HOW MUCH AND HOW OFTEN SHOULD CANOLA OIL BE SPRINKLED IN GROWER/FINISHER BARNS

Y. Zhang, A. Tanaka, E.M. Barber, J.J.R.Feddes

Summary

Dust concentrations in animal buildings can be reduced by sprinkling a small quantity of canola oil. The sprinkling pressures and oil temperatures have already been defined (PSCI 1994 Annual Research Report). However, we have not yet optimized how much and how often oil application should be conducted to reduce dust concentrations. In this study, canola oil was sprinkled at six application rates in three identical swine growing/finishing rooms. For the six oil application rates, dust concentration was reduced between 37% to 89%. Sprinkling more often was more effective than less often in terms of dust reduction. However, sprinkling more often than once a day is difficult when the oil application is less than 10 mL/m2 per day. Sprinkling more oil can reduce more dust, but a daily dosage of more than 10 mL/m2 caused greasy floors. Variable daily dosages for oil sprinkling had a higher efficiency of dust reduction than a constant daily dosage. A recommended variable oil sprinkling dosage is 40 mL/m2 for the first two days, 20 mL/m2 for the second two days and 5 mL/m2 for the rest of production cycle with a 20 mL/m2 surge every two weeks. For grower/finisher units, this oil sprinkling schedule can reduce dust by 80% using only 0.5 L oil per pig marketed.

Experimental Procedure

Animal Facilities and Management

This study was conducted in the growing -finishing research barn at Prairie Swine Center, Saskatoon, Saskatchewan, Canada. Three identical growing -finishing rooms, two treatments (Rooms A and B), and one control (Room C) were used. Although the building was designed for research, the room dimensions, building materials and construction techniques are similar to those used for commercial swine production. During the experiment, each room used measured 14.3 m by 11 m by 3 m and held 144 pigs in 12 pens, 12 pigs per pen. The pen floor was partially slatted (30% of the pen area). A 0.6 m deep manure collection channel was located beneath the slotted portion of the floor. Interior walls had plywood cladding on both sides of a stud wall frame. A bank of propeller fans (total air delivery capacity 6,500 L/s at 20 Pa) exhausted air at one end wall of the room. Unit block air inlets were located in the ceiling. Fresh air entered the attic through screened soffit openings. Heat in each room was supplied by an unvented natural gas unit heater. An electronic controller regulated the sequencing and speed of exhaust fans, the opening area of supply inlet modules, and the operation of the heaters.

Assignment to Treatment

A total of 432 pigs were housed in three rooms, 144 pigs in each room. The average weight of animals was 25±5 kg per pig at the time the rooms were assigned to treatment. The pigs in the rooms were managed following normal commercial procedures, with identical procedures followed in each room. For example, if one pen in a treatment room was cleaned, corresponding pens in the other two rooms were also cleaned so that the dust in all three rooms was disturbed to the same extent. Extra management activities in the rooms (such as pulling up a manure pit plug) were recorded, the time and activity type.

Crude canola oil was used for this study because it is safe for animals, is readily available, and less expensive than other vegetable oils. Six combinations of frequencies and quantities (QF1 to QF6) of oil application were tested (Table 1).

The six oil treatments were conducted in treatment Rooms A and B and the dust concentrations were compared with the control Room C over the 11-week production cycle. These six oil application treatments were conducted in three time periods. Each time period utilized two treatment rooms and one control room as shown in Table 2.

Week 1 was considered as the acclimation period for pigs to settle down in their new environment. During weeks 2 and 3, treatments QF1 and QF3 were applied in Rooms A and B, respectively. Oil was not sprinkled during week 4 so that dust levels in Rooms A and B would increase nearly to the level of the control room (Room C). QF3 and QF4 were compared during weeks 5 to 7. The total oil applied was the same during the first two time periods of the experiment. Thus, the effect of oil residue affecting the next period was expected to be the same for both rooms. Only during the last period (QF5 and QF6 during weeks 10 and 11), was oil consumption different for the two treatment rooms.

A backpack sprayer designed for chemical spraying was used. The shape of the nozzle opening was circular. When sprinkling, the nozzle was approximately at a height of 0.8 m above the floor (pen partition level). Sprinkling covered the entire floor area including pen (sleeping and dunging areas), pig body and room walkways.

Data Collection and Instrumentation

Respirable and inhalable dust concentrations at three levels, 0.2, 1.6 and 2.4 m above the floor at the center of the operator's walkway, were measured at approximately 9:00 and 16:00 h daily using a laser particle counter (Met-One, Model 227B). This apparatus counted particles per milliliter in four particle size groups: 0.3 - 0.5, 0.5 - 1.0, 1.0 - 5.0 and >5.0 (m in diameter. Before each measurement, normal room management activities were simulated by walking through the walkways once. The daily average inhalable dust mass concentration (mg/m3) was measured using mass samplers (Gil-Air, Model Aircon2). Dust mass samples were collected on Mondays, Wednesdays, and Fridays.

Room temperatures and pressure across the exhaust fans and air inlets were measured and recorded continuously using a data logger and a computer data acquisition system. Relative humidity was measured at the center of the operator alley. Air velocity was measured at pig levels in three pens located at the center and both ends of the room. Ventilation rates were calculated from room temperature, fan schedule, pressure and fan curves. Carbon dioxide concentration was also used as an indicator of ventilation rate.

Results and discussion

As particles smaller than 0.5 (m in swine buildings are primarily from outside air origin, this discussion is limited include only modified respirable and modified inhalable dust concentrations (referred to as modified since the very small background dust <.5 (m is not included). Respirable dust is classified as particles under 5 (m and represent a potential health risk because their small size allows them to move deep into the lungs. Inhalable dust includes all particles under 50 (m. For a complete discussion of dust size classification see the 1993 Annual Research Report, p. 41 or Swine Building Ventilation published by Prairie Swine Centre. A summary of the data on dust concentrations at the three levels, 0.2, 1.6 and 2.4 m above the floor, is shown in Table 3. Dust concentrations were reduced consistently when oil was sprinkled throughout the 11 week experimental period.

As shown in Table 3, both the respirable and inhalable dust concentrations were not significantly different at various heights above the floor. In an earlier study, we reported (1993 Annual Research Report) that the dust deposition rates in pig buildings varied with the distance above floor. The differences between the two reports is suspected to be two fold: (1) some large particles (a major mass contributor) may not be sampled by the laser particle counter due to the sampling efficiency; and (2) dust deposition at the lower levels of a room airspace increased due to occasional events such as loading feed. These events could significantly change dust deposition at the lower levels of a room but were not included when particle counts were measured.

Effect of Frequency of Oil Sprinkling Event

The effects of oil sprinkling on concentrations of modified respirable dust and modified inhalable dust were similar. The mean concentration of respirable dust was 15.5 ± 5.0 in Treatment 1 (QF1), 19.3 ± 8.3 count/mL in Treatment 2 (QF2) and 29.5 ± 6.4 count/mL in control. Compared with the control, the reduction of modified respirable dust for Treatment 1 and Treatment 2 are 47.3% and 34.3%, respectively. The mean concentrations of inhalable dust was 24.3 ± 7.3 count/mL for Treatment 1, 31.0 ± 13.0 count/mL in Treatment 2 and 46.7 ± 9.9 count/mL for control. The reduction of modified inhalable dust was 47.9% and 34.6% for Treatment 1 and 2, respectively..

Dust concentrations for both modified respirable dust and modified inhalable dust in Treatment 1 was 13% lower than in Treatment 2. The variability of the dust count reduction in Treatment 1 was smaller than that in Treatment 2. This indicated that sprinkling every day could reduce the dust concentration more effectively than sprinkling every other day. A higher sprinkling frequency was considered not practical because the quantity of oil sprinkling was small. It is difficult to sprinkle uniformly when a dosage is smaller than 10 mL/m2.

Effect of Quantity of Oil Application

The effect of quantity of oil application can be examined from Treatments 1 to 4 and the control. The oil application of Treatment 3 (QF3) was 20 mL/m2 every day for three weeks. The oil application of Treatment 4 (QF4) was 30 mL/m2 per day for the first week, 20 mL/m2 per day for the second week and 10 mL/m2 per day for the third week. The total amount of oil sprinkled during the Treatments 3 and 4 were equal (Table 3). The mean concentration of modified respirable dust was 10.3 ± 8.1 count/mL in Treatment 3, 6.6 ± 3.3 count/mL in Treatment 4 and 45.8 ± 7.0 count/mL in control. The reduction rate was 77.5% for Treatment 3 and 85.5% for Treatment 4. The mean concentration of modified inhalable dust was 15.8 ± 14.7 count/mL in Treatment 3, 9.0 ± 3.8 count/mL in Treatment 4 and 78.5 ± 14.1 count/mL in control. The reduction rate of modified inhalable dust concentration was 79.8% for Treatment 3 and 88.5% for Treatment 4. Comparing the dust reduction in Treatments 3 and 4 to the reduction in Treatments 1 and 2, it is apparent that more dust could be reduced when more oil was sprinkled. However, oil application rate must be balanced by the cost of oil and 'oiliness' of the airspace. It was observed that walkways appear slippery at a daily dosage of 20 mL/m2.

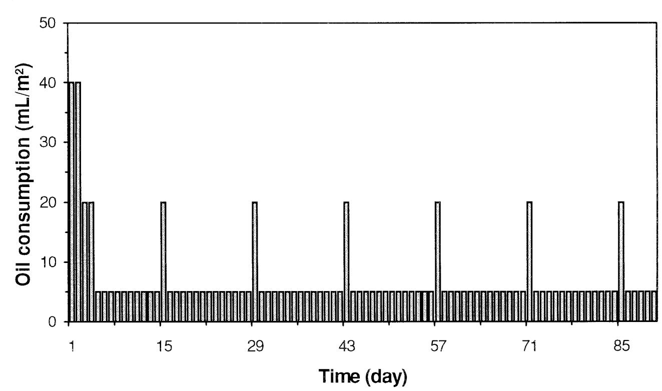
From Table 3, Treatment 4 shows more dust reduction than Treatment 3. Sprinkling large amounts of oil for the first few days reduced the dust count level very quickly and in the following days a smaller amount of oil was able to maintain the dust concentration at a low level. This indicates that a variable daily dosage (apply more oil for the first few days and less oil in the latter days) was more effective in dust reduction that a constant oil application dosage.

Based on the results of Treatments 1 to 4, Treatment 5 and 6 can be considered as a fine-tuning of the variable dosage. The oil consumption for Treatment 5 was 40 mL/m2 for the first two days, 20 mL/m2 for the next two days and 10 mL/m2 for the last eight days. The oil consumption for Treatment 6 was 40 mL/m2 for the first two days, 20 mL/m2 for the next two days and 5 mL/m2 for the last eight days. Since Treatments 5 and 6 were the last time period and no later treatment would be affected, the total oil application for these two treatments could be different.

The average concentration of respirable dust was 10.2 ± 4.4 count/mL in Treatment 5, 10.5 ± 4.4 count/mL in Treatment 6 and 54.9 ± 7.6 count/mL in control. The reduction rate was 81.4% for Treatment 5 and 80.9% for Treatment 6. The concentration of modified inhalable dust was 11.2 ± 4.5 count/mL for Treatment 5, 12.2 ± 5.2 count/mL for Treatment 6. The dust reduction rates were 88.1% for Treatment 5 and 87.1% for Treatment 6. The difference between the dust count concentration of Treatment 5 and that of Treatment 6 was not significant although Treatment 6 used much less oil. The oil consumption in Treatment 5 for the last eight days was twice that of Treatment 6. In terms of dust reduction and oil consumption, Treatment 6 showed the best performance in terms of high dust reduction, low oil consumption and cleanliness in the barn.

One oil sprinkling formula for grower/finisher rooms is to sprinkle 40 mL/m2 per day for the first two days, 20 mL/m2 per day for the second two days and 5 mL/m2 per day for the rest of days. After each two weeks of 5 mL/m2 application, a 20 mL/m2 surge (one day) might be needed to keep the dust concentration down (Figure 4). This surge is applied only once every two weeks. Using this schedule, both respirable and inhalable dust concentrations were reduced by 80% without greasy problem (too much oil on floor). Approximately 0.6 L of oil were was used for each grower/finisher pig.

Figure 4. A recommended oil sprinkling schedule for all-in-all-out swine buildings.



Conclusion

The following conclusions can be drawn from the short term spectrum study:

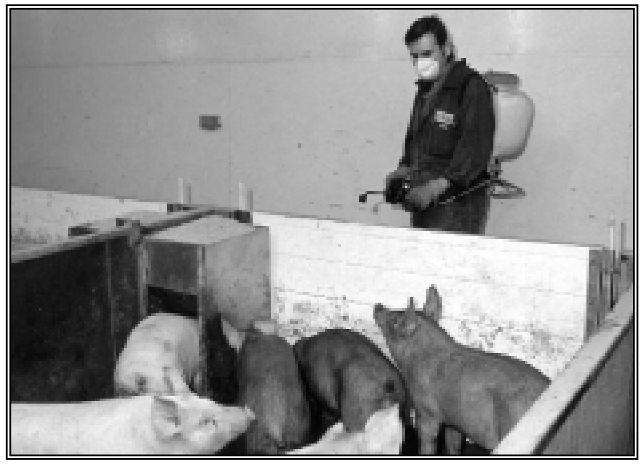
- Oil sprinkling reduced the concentration of dust effectively, ranging from 37 to 89% reduction depending upon the oil application rates. The overall mean reduction of respirable and inhalable dust concentrations were 71 and 76% respectively for six oil application rates.

- A higher oil application frequency was more effective than the lower application frequency in terms of dust reduction. Sprinkling of oil every day showed that both modified respirable dust, and modified inhalable dust were reduced 13% more than that of sprinkling every other day. However, sprinkling more often than once a day is difficult when the oil application rate is less than 10 mL/m2 .

- The more oil sprinkled, the more dust could be reduced. However, slippery walkways were observed when a daily dosage of 20 mL/m2 was applied. Average daily dosage should not exceed 10 mL/m2.

- Variable daily dosages for oil sprinkling had higher efficiency of dust reduction than a constant daily dosage. Applying more oil the first few days reduced dust concentration quickly and subsequently required less oil in the following days to maintain low dust concentrations.

- Treatment 6 (QF6), which applying 40 mL/m2 for first two days, 20 mL/m2 for the second two days and 5 mL/m2 for the remaining days, was found to be both effective and economical.



Technician Darryl Wurtz applying oil with backpack sprayer

Table 1. Oil application treatments and descriptions

Treatment*	Description
QF1	10 mL/m2 daily for two weeks.
QF2	20 mL/m2 every other day for two weeks.
QF3	20 mL/m2 daily for three weeks.
QF4	30 mL/m2 for week 1, 20 for week 2 and 10 for week 3.
QF5	40 mL/m2 daily for the first two days, 20 mL/m2 daily for the second two days, and 10 mL/m2 for the remaining 10 days.
QF6	40 mL/m2 daily for the first two days, 20 mL/m2 daily for the second two days and 5 mL/m2 for the remaining 10 days.

* Q - indicates quantity used, F - indicates frequency applied.

Table 2. Schedule of oil application treatments and room assignments.

Time schedule (week)	1	2	3	4	5	6	7	8	9	10	11	
Room A	QF1	QF1		QF3	QF3		QF3				QF5	QF5
Room B	QF2	QF2		QF4	QF4		QF4				QF6	QF6
Room C	ctrl	ctrl		ctrl	ctrl		ctrl				ctrl	ctrl

Acknowledgement

The authors acknowledge funding for this project from Saskatchewan Agricultural Development Fund (ADF), and National Science and Engineering Research Council (NSERC) of Canada and Canodev Research Inc. (formerly Saskatchewan Canola Development Commission).

Table 3. Summary of dust concentrations

Above floor (m)	Dust class[1]	Oil sprinkling treatment							
		QF1			QF2			Control	
		Mean[2] (Cts/mL)	SE (Cts/mL)	Reduction (%)	Mean (Cts/mL)	SE (Cts/mL)	Reduction (%)	Mean (Cts/mL)	SE (Cts/mL)
0.2	Mod. res.	15.4	5.2	46.8	19.2	8.4	33.6	28.9	6.8
1.6	Mod. inh.	23.8	7.4	48.3	30.3	12.8	34.0	45.9	14.8
	Mod. res.	15.7	5.0	46.6	18.8	7.9	35.8	29.3	6.5
2.4	Mod. inh.	24.6	7.2	46.9	30.2	12.2	35.0	46.4	9.9
	Mod. res.	15.5	5.0	48.5	20.0	8.9	33.5	30.1	6.3
	Mod. inh.	24.6	7.5	48.5	32.5	14.4	32.0	47.8	9.9
Mean	Mod. res.	15.5	5.0	47.3	19.3	8.3	34.3	29.5	6.4
	Mod. inh.	24.3	7.3	47.9	31.0	13.0	33.6	46.7	9.9
		QF3			QF4			Control	
0.2	Mod. res.	10.6	8.3	75.3	6.9	4.0	83.9	42.9	6.6
	Mod. inh.	16.3	15.1	79.3	9.3	4.3	88.3	78.8	13.3
1.6	Mod. res.	10.4	8.5	77.2	6.6	3.3	85.5	45.7	7.7
	Mod. inh.	16.1	15.4	79.2	8.9	3.8	88.5	77.3	15.0
2.4	Mod. res.	9.8	7.5	78.7	6.3	3.4	86.3	46.2	7.5
	Mod. inh.	15.1	13.9	80.8	8.9	3.4	88.7	78.5	15.7
Mean	Mod. res.	10.3	8.1	77.6	6.6	3.3	85.5	45.8	7.0
	Mod. inh.	15.8	14.7	79.8	9.0	3.8	88.5	78.2	14.1
		QF5			QF6			Control	
0.2	Mod. res.	10.2	4.4	80.7	10.6	4.4	79.9	52.8	7.7
	Mod. inh.	11.2	4.5	87.4	12.2	5.2	86.2	88.8	28.2
1.6	Mod. res.	10.1	4.5	81.5	10.5	4.5	80.8	54.8	8.3
	Mod. inh.	11.1	4.6	88.2	12.3	5.3	86.9	94.0	17.7
2.4	Mod. res.	10.2	4.3	82.1	10.3	4.3	81.9	57.1	7.8
	Mod. inh.	11.3	4.4	88.7	12.0	5.2	88.0	100.0	17.5
Mean	Mod. res.	10.2	4.4	81.4	10.5	4.4	80.9	54.9	7.6
	Mod. inh.	11.2	4.5	88.1	12.2	5.2	87.1	94.2	16.4

[1] Mod. res. = modified respirable dust; Mod. inh. = Modified inhalable dust.

[2] cts/mL = count/mL

MARKETING BY PIG OR BY PEN

MARKETING BY PIG OR BY PEN -WHICH IS MOST ECONOMICAL?

G.I. Christison, S.D. Fortowsky and N.F. Cymbaluk

Summary

The most common method of marketing grower-finisher pigs is to sell individual pigs that have reached a pre-set target weight that typically maximizes carcass index. However, marketing for the highest carcass index does not guarantee the highest net revenue for each hog or for the barn. For example, if no replacements are added to the pen when individual pigs are sold, the barn cannot operate at full capacity.

Marketing method can affect barn efficiency. In this study we consider two such marketing methods. The first method simply sells all pigs in the pen when the average pen weight reaches 105 kg. A second method is to market pigs individually as each pig reaches 105 kg. An extra step in the latter method is to regroup and mix the remaining pigs from several pens into a single, full pen. Pigs are often mixed and sorted in nurseries and at entry into feeder barns to maximize pig uniformity and space utilization. Mixing finisher pigs is less common because finisher pigs may fight more and experience poorer gains after mixing.

Testing new management approaches such as different marketing schemes or mixing near- market pigs is financially impractical on most farms. We have used a less costly method to test these economic effects by using a computer model to simulate these marketing schemes.

Experimental Procedure

A computer simulation program (MKTPIG) was developed using data collected in a study of nine typical Saskatchewan grower-finisher units funded by the Federal Economic Regional Development Agreement (ERDA). Carcass data were based on the ERDA study. Carcass grade and values were obtained from the 1991 Saskatchewan Hog Settlement Table. Other production costs were calculated from data in the 1993 Guidelines for Estimating Swine Production Costs used by Manitoba Agriculture. Simulations were conducted over a 365-day period and included a 40-day lead period to eliminate economic inefficiencies associated with barn fill.

The model is based on production of grower-finisher pigs starting at an average of 40 kg and finishing at about 105 kg body weight. Pigs were simulated to grow at variable rates assuming daily gain variation based on the ERDA data. Pigs were sold in three ways: as individual pigs, with or without mixing, or as pens of pigs (Figure 1). A target weight of 105 kg was chosen because this has been suggested to result in the highest carcass index. However, when marketing by pen, individual pigs could be sold at weights ranging from 95 to 115 kg. Thus, the highest carcass index would not be obtained for many pigs in that pen.

Marketing of individual pigs allowed a choice of mixing or not mixing. If mixing was chosen, the depression in gain due to mixing (mixing factors) and the percentage of available space in the pen to be filled could be specified. This ensured that the pen was filled by a desired number of pigs. Pigs were remixed with other pigs that were within ± 10% of their body weight which prevented one large pig from being put into a pen with juveniles.

Mixing may reduce growth rate in the first week after mixing. Growth depression gradually declines over the next two weeks. The net effect of mixing has been found in a variety of trials conducted elsewhere to average about 6% over three weeks based on reductions in daily gain of 11% in week 1, 5% in week 2 and 2% in week 3. This was termed the mixing factor.

Results and Discussion

Selling by Individual versus by Pen

The initial comparison evaluated the economic effects of marketing pigs as individuals or by pen. No mixing occurred. This simulation assumed that new feeder pigs would enter the barn on market day if there was space in the barn. The exact number of pigs needed to fill the pens was used. However, in the by pig model, removing single pigs from the pen could leave the pens understocked but not empty (Figure 1). In the by pen model, there were some weeks when no pens of pigs were ready for market and no pens to fill. Understocking or lack of empty pens caused barn fill and numbers of pigs sold weekly to fluctuate (Figure 2). Sporadic filling caused greater weekly variation in pigs sold in the by pen model. Yet, barn fill was about 10% higher when it was emptied by pen rather than sold by individual.

The results of the simulation of marketing by pen or by individual pig for Barn C are given in the two middle columns in Table 1. Responses were similar in the other eight ERDA barns. Marketing by pen yielded a higher yearly output of hogs per barn. For barn C, 30% more pigs were sold per year when sold by pen (1824) rather than by individual (1407). The difference arose because a few slow-growing pigs in the latter scheme could occupy a pen for extended periods thereby lowering pen occupancy and barn throughput. In practice, this would not occur because slow growers would be grouped with other pigs. Selling by pen, however, markedly reduced carcass index because of wide variation in final live weight of pigs sold. The lower carcass index in turn reduced carcass value by as much as $4.53.

Selling by Weight with Mixing or No Mixing Compared to Selling by Pen

The management of near market pigs remaining in understocked pens has always been a problem for the hog producer who must ask the question "Is it more economical to keep the barn full by regrouping pens of pigs and risking slower gain or to leave the pigs in an understocked pen growing at a maximum rate?" This question assumes that mixing finishing hogs will result in growth depression. Yet, the average slowing in gain due to regrouping and mixing pigs has been reported to only be 6% over the three week period after mixing. We evaluated the cost of mixing versus not mixing finisher pigs by assessing barn productivity in the following situations:

- Examining barn data in which pigs were not mixed (even if the pens were understocked) and
- By regrouping or mixing similar-sized pigs remaining after pigs of 105 kg were sold from their pens. Mixing factors of 0 and 6% were used. The 0% factor tested the hypothesis that weight gain was not depressed by mixing—which has been found in some experiments.

The number of pigs sold was about 25 - 28% greater in the nine barns when pens of pigs were remixed after individuals were sold. This improvement occurred regardless of whether a 0 or 6% mixing factor was used. Assuming a 0% mixing factor (1797) resulted in 2% higher production of pigs over individually marketed pigs slowed by a 6% mixing factor (1760) (Table 1). However, the number of pigs and total carcass weight sold by pen was 1.5-3.6% higher than numbers sold by individual if mixing was allowed. These values ranged from 3 - 5.8% in the eight other barns examined.

Individually marketed hogs stayed in the barn up to 2.8 days longer than those marketed by pen. In other barns, individually marketed pigs took 4.7 to 5.7% more time to reach 105 kg. However, pigs sold by pen had a considerably lower carcass index than those sold as individuals. Individually-marketed pigs were always sold at 105 kg and were always within the core weight range whereas pigs sold by pen could be above or below core weight range.

In conclusion, these simulations show that marketing by individual pig when mixing is allowed is more economical than marketing by pen. Although mixing may cause a temporary reduction in weight gains, it maximizes barn occupancy, carcass index and carcass value, over selling pigs by pen.

Table 1. The effect of marketing finisher pigs by pen or by individual, with or without mixing, over a 1-year cycle (Example, Barn C)

	By Pen	Individual - No Mix	Individual - Mixed with Mixing Factor 0%	6%
Hogs sold	1824	1407	1797	1760
Carcass weight (tonnes)	195.9	151.3	193.2	188.6
Feed eaten (tonnes)	414.3	325.1	409.5	411.3
Daily gain (kg/d)	0.714	0.714	0.725	0.706
Feed/gain ratio	3.37	3.42	3.37	3.47
Carcass index	99.8	103.7	103.9	103.8
Carcass value ($)	110.11	114.64	114.82	114.36

Figure 1. Pathways for marketing pigs: 1A - sold by pen; 1B - sold individually, pens not remixed; 1C - sold individually, pens remixed.

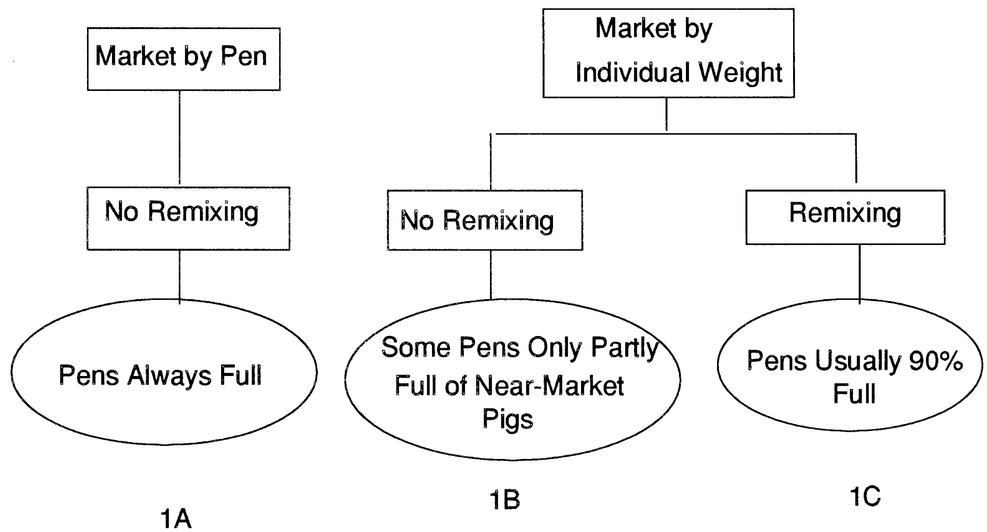
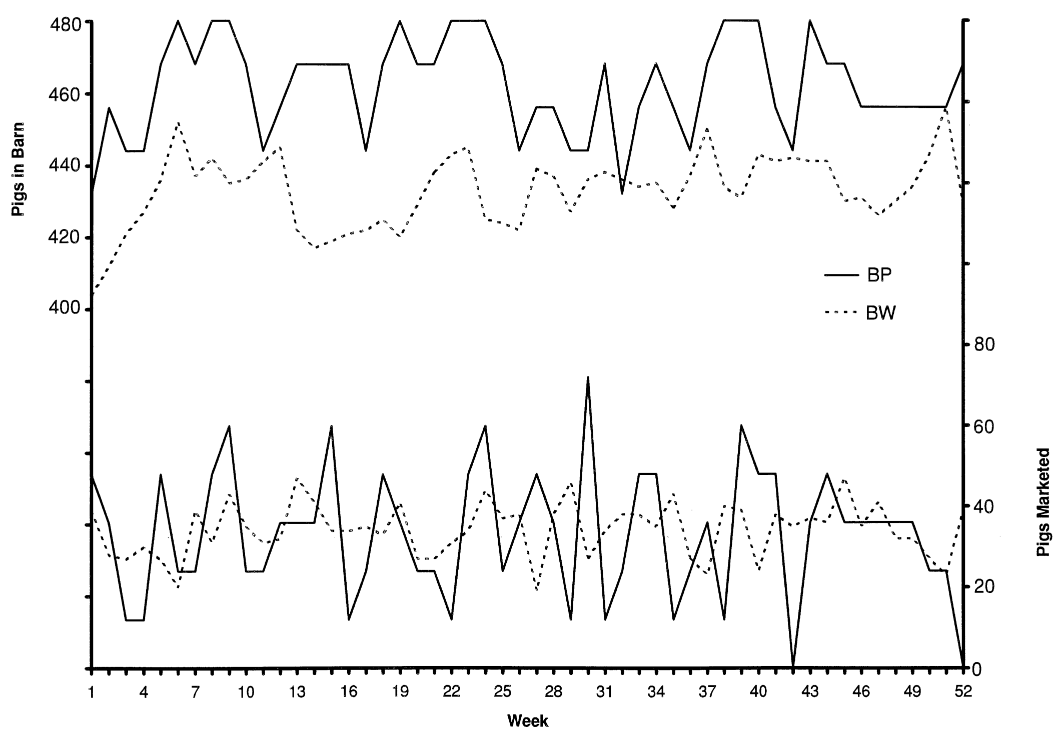


Figure 2. Number of pigs in the barn, and number of pigs marketed each week when marketing was by pen (BP ___) or by weight (BW - - -).



SORTING GROWER-FINISHER PIGS

THE EFFECT OF SORTING GROWER-FINISHER PIGS

G.I. Christison, S.D. Fortowsky and N.F. Cymbaluk

Summary

Sorting means mixing pigs into pens according to size and is commonly used to maximize use of barn space when feeder pigs are brought into a grower-finisher barn. Although most producers find that sorting newly-weaned pigs has little effect on productivity, sorting grower-finisher pigs can reduce gains. This is most evident if regrouping is done late in the grower period. The reason large pigs gain more slowly after sorting has been attributed to disruption of the social status within the pen. In a newly-grouped pen, aggressive, dominant pigs may interfere with feeding and drinking by subordinates. This reduces overall pen gain.

Experimental Procedure

The computer simulation program (MKTPIG) used in the previous report was used for a 365-day simulation, in which pigs were started at an average of 40 kg and finished at 105 kg. The main comparison examined effects of marketing by pen or by individual. However, within each marketing scheme, production was also compared in which grower-finisher pigs were either not sorted, sorted at entry (about 40 kg) or sorted at 75 kg body weight.

Results and Discussion

The effect of sorting on productivity of Barn C is given in Table 1. As shown in the previous paper, more pigs were sold per year when pigs were sold by pen rather than by individual pig. This was true whether sorting did or did not occur because pigs sold by pen stayed in the barn for a shorter period than those sold individually (94.5 versus 98.9 for not sorted, 96.3 vs 97.5 days for those sorted at 75 kg). Regardless of whether pigs were sold by pen or by individual, the highest numbers of pigs sold per year and, therefore, the highest total carcass weight sold occurred when pigs were sorted at an average of 40 kg body weight.

Sorting had little effect on daily gain except when sorting occurred at 75 kg. Daily gains decreased from about 0.719 kg/d for marketing by pen to 0.708 kg/d after sorting at 70 kg. When marketing by pigs individually, daily gain decreased from 0.710 kg/d when pigs were not sorted to daily gains of only 0.703 kg when pigs were sorted at 75 kg. Slower gains are associated with competition and fighting among larger pigs but are also due to the shorter time available for pigs to regain weight before being sold. Feed to gain ratios were greater for pigs sorted at 75 kg largely as a result of lower daily gains.

Selling by pen had a detrimental effect on carcass index and carcass value. Sorting did not counteract the negative effects of marketing by pen except for pigs sorted at 75 kg which showed an improved carcass value. Non-sorted pigs marketed by pen had a carcass value of $106.61 which increased to $110.29 if pens were sorted at 75 kg. The low carcass value of not-sorted pigs ($106.61) and 40-kg sorted pigs ($107.66) occurred due to low carcass indices (about 97). By contrast, carcass value of pigs sold as individuals (about $113) was little affected by sorting because carcass index was nearly constant (100.4 to 102.5).

Discussion

Sorting grower-finisher pigs at 75 kg body weight reduced numbers of pigs sold by pen and, consequently, the total carcass weight of pigs sold by pen. Sorting had more positive effects on these criteria for pigs sold individually. Sorting at 75 kg reduced daily gain regardless of marketing method of finisher pigs. Starting weight and final weight are not highly correlated so more pronounced outcomes would be expected for pigs sorted closer to their final selling weight. If mixing affects productivity for three weeks then mixing should precede marketing by 3 to 4 weeks.

Conclusion

In conclusion, sorting improved barn fill and the stability of marketing especially when marketing by pen. The model predicted improved facility performance when the pigs were sorted at 40 kg (entry). No benefit was obtained from sorting more than once. Although non-littermates fight when sorted and mixed, it appears that creating uniform pens of pigs provides an advantage in daily gain, barn fill and, hypothetically, net revenue.

Table 1. The effect of not sorting or sorting at 35 or 70 kg BW on productivity of pigs sold by pen or individually

	No Sort		Sort at entry 40 kg		Sort at 75 kg		Average	
	By Pen	By Wt	By Pen	By Wt	By Pen	By Wt	By Pen	By Wt
Pigs sold	1848	1773	1884	1787	1812	1777	1848	1779
Days in barn	94.5	98.9	94.5	96.6	96.3	97.5	95.1	97.7
Total carcass weight sold, tonnes	199.7	193.5	202.4	191.9	194.8	190.8	198.97	192.07
Total feed used, tonnes	419.3	420.9	427.2	414.3	418.7	415.8	421.7	417.0
Daily gain, kg/d	0.719	0.710	0.715	0.712	0.708	0.703	0.714	0.708
F:G (kg feed/kg gain)	3.34	3.45	3.36	3.43	3.42	3.47	3.37	3.45
Carcass index	96.5	100.4	97.9	102.5	100.0	102.5	98.1	101.8
Carcass value,$	106.61	112.64	107.66	113.09	110.29	113.07	108.19	112.93

INSULIN GROWTH FACTOR 1 IN WEANLING-GROWING PIGS

ONTOGENY OF SERUM INSULIN-LIKE GROWTH FACTOR-I IN PIGS FROM BIRTH TO 65 DAYS OF AGE

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Summary

Insulin-like growth factor-I (IGF-I) is a 70 amino acid, single chain polypeptide hormone and an important regulator of cell growth and differentiation. Most fetal and adult tissues synthesize IGF-I although the liver is the major source of IGF-I found in the circulation. During fetal life circulating IGF-I levels are low, however, after birth, concentrations gradually increase. Considerable evidence supports a primary role for IGF-I in regulation of postnatal growth.

Most IGF-I occurring in plasma and other body fluids is bound to one of 6 identified IGF binding proteins (IGFBP). These binding proteins prolong the half life of IGF-I in plasma and may either potentate or inhibit IGF-I effects on body tissues. The concentration of individual IGFBPs in body fluids therefore has a significant impact on the biological activity of circulating IGF-I.

Plasma concentration of IGF-I is mediated by a complex interaction among nutrient quantity and quality as well as other factors such as stress and disease. These factors are also likely to influence the circulating concentration of IGFBP. Knowledge of the changes in blood levels of IGF-I and IGFBP under current swine management conditions may provide a basis to determine the impact of various management practices on piglet growth and welfare.

Objectives

- To determine the impact of factors such as weaning and phase feeding on serum IGF-I level in piglets.
- To examine the relationship between the levels of circulating IGF-I and body weight gain.
- To determine the effects of parity of the dam (gilt vs. sow) and sex of piglet (male vs. female) on serum IGF-I concentration.

Material and Methods

Animals:

One male and one female piglet (close to the mean litter weight) was selected from each of 8 gilt and 8 sow litters. Piglets were offered creep feed at 7 days and were weaned at 3 weeks of age. After weaning, piglets were fed a phase I diet for 10 days followed by a phase I (50%) + phase II (50%) for a further 10 days . The phase II diet was fed until the piglets reached approximately 17 Kg of body weight. After this time, piglets were moved from nursery to finishing room and fed a phase III diet. Phase I, II, and III diets were purchased from Federated Co-op.

Experimental:

Blood samples were obtained by jugular vein puncture at 2, 4, 8, 14, 20, 21, 22, 23, 25, 28, 31, 32, 33, 34, 36, 41, 42, 43, 44, 46, 52, 59, 60, 61, 62 and 64 days of age. Reduced sampling intervals coincided with weaning and diet changes. Blood samples were allowed to clot at room temperature for 2-3 hours before serum was separated and stored at -20 C until assayed by radioimmunoassay for IGF-I.

All the piglets were weighted regular interval 7 days.

Statistical analysis:

Differences between group sex and parity were determined by two -way analysis of variance (ANOVA). Correlation between IGF-I level and weight gain was assessed by linear regression analysis.

Figure1:

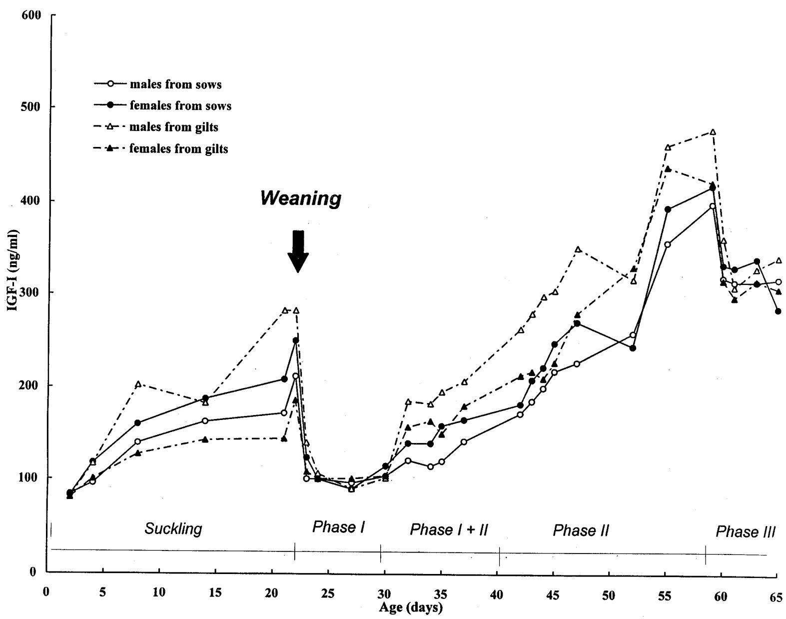
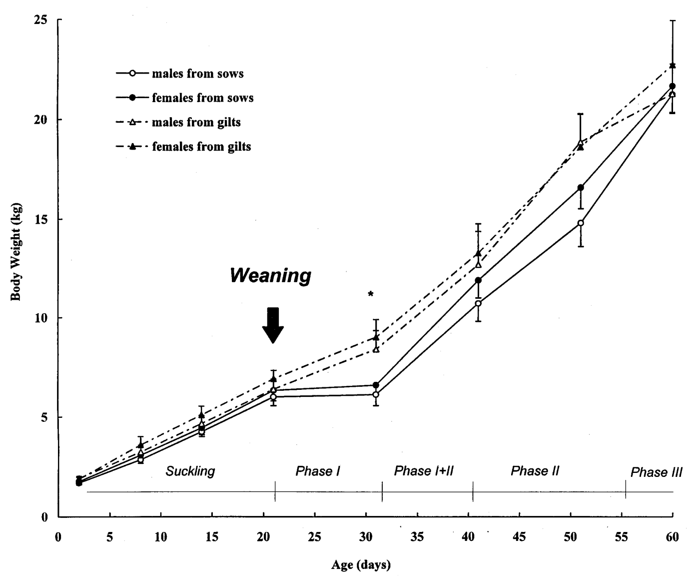


Figure 2:



Results and Discussion

Serum IGF-I level was low at birth and increased gradually with age (Figure 1). IGF-I level was 2.5-3.5 fold higher at 3 weeks age than that of birth. For reasons which are unclear, IGF-I levels in female piglets were significantly ($P<0.05$) higher than in males during the suckling phase and the phase I + II feeding period. No significant difference in IGF-I level was observed between piglets from sows and gilts. Weaning resulted in a dramatic decline in serum IGF-I. IGF-I concentration remained low for approximately 10 postweaning days during feeding of the phase I diet and gradually increased when the diet was switched from phase I to phase I + II. Circulating IGF-I levels did not recover to preweaning values until approximately 3 weeks after weaning. A second marked decline in IGF-I concentration occurred when the diet was switched from phase II to phase III. Similar to the situation at weaning, the shift from the phase II to the phase III diet was accompanied by additional stresses including moving from the nursery to the growth area and mixing of penmates.

Variation in serum concentration of IGF-I is commonly associated with variation in body weight. The data of this study confirms that IGF-I level is highly correlated with growth rate. A strong positive correlation ($r=0.84$, $P<0.01$) was observed between serum IGF-I and body weight. Fig 2 illustrates that IGF-I concentration roughly paralleled the increase body weight.

At 3 weeks of age the suckling piglet remains almost completely dependent on the sow or gilt for nutrition. Although capable of extracting nutrients from highly digestible milk the gastrointestinal tract of the 21d old pig is immature and poorly equipped to deal with solid plant based diets. The immune system of 21d old pig is similarly immature. Antibodies and other factors present in sow or gilt milk are receiving increased attention for their protective effect against enteric disease in the neonates.

Accordingly, weaning represents a significant insult to the baby pig. Physiological limitations to growth including a digestive tract unsuited to the diet and increase susceptibility to disease are compounded by the social stress of mixing littermates and removal from the dam.

The physiological and social stresses of weaning were reflected in the current study in a persistent and dramatic decline in circulating IGF-I. Analysis of circulating IGF-I levels therefore seems to represent a very sensitive measure of weaning stress. Future investigation will utilize circulating IGF-I as a measure of the impact of various management and nutritional approaches to weaning on piglet performance and welfare.

VACCINATION WITH SUBUNIT BACTERIN REDUCES MORTALITY DUE TO *Streptococcus suis* IN AN ENDEMICALLY INFECTED HERD

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Summary

Disease caused by infection of piglets with *Streptococcus suis* is responsible for some of the most significant and disturbing losses in swine production. The disease is recognized by many producers and veterinary swine specialists as the most important infectious disease currently affecting swine production in North America.

The three main objectives of this vaccine trial were to control disease in piglets by vaccinating sows in an infected herd, to determine whether vaccination alters anti-*Streptococcus suis* antibody titre in sow colostrum, and to compare the disease in two groups that were vaccinated with subunit bacterins to a control group. Two strains of *S. suis* (serotypes 3 and 9) were isolated from untreated pigs showing signs of meningitis in this herd. Two subunit vaccines (A and B) were prepared from a combination of both of these strains and were combined with adjuvant. The control group was given placebo vaccine (C) prepared from sterile saline and adjuvant. Sows and gilts were randomly assigned to one of the three groups and were vaccinated intramuscularly at four weeks before farrowing and one week before farrowing. Barn staff recorded the identification of pigs that died and whether they showed signs of *S. suis* disease prior to death. The antibody titre in the colostrum of the sows that were vaccinated with vaccine A (titre of 3581) or vaccine B (titre of 1807) was significantly ($P < 0.01$) greater than the titre in the colostrum of the control sows (titre of 109). Likewise, piglets nursing sows vaccinated with A or B vaccines had greater antibody titres than piglets nursing control sows. The number of piglets born alive was not different among groups A, B or C, but more pigs in control group C died of *S. suis* disease than in vaccine groups A or B. In conclusion, both vaccine A and vaccine B reduced death from *S. suis* disease in litters from sows or gilts vaccinated with either of them. Both the vaccinated sows and their piglets had more antibody than controls.

Introduction

Throughout Canada, *Streptococcus suis* is responsible for a wide variety of diseases in pigs including meningitis (brain infections), polyserositis (arthritis), septicemia (generalized infection throughout the piglet), pneumonia, abortions and others. The meningitis and poor viability in weaned pigs can be particularly disturbing to barn staff who are trying to produce healthy, vigorous livestock.

These Gram positive bacteria are also responsible for a wide variety of infections in older swine. Although older animals are less likely to develop meningitis, infected older pigs can have arthritis, pneumonia, other diseases or serve as carriers of the infection and transmit it to young pigs. A recent study compared six types of medicated early weaning (MEW) management techniques that are often used to try to break the chain of infection, but found that none were able to prevent infection of piglets by *Streptococcus suis*. Infected pigs at the slaughter plant also represent a threat to human health. *S. suis* can cause serious disease in which deafness is a frequent result of *S. suis*-induced meningitis in people. As a zoonotic disease (which can spread from animals to people), it is important to control to maintain export markets. Pork worth over three-quarters of a billion dollars was exported from Canada in 1993.

These studies were conducted in order to develop an effective subunit vaccine for the prevention of *S. suis* disease in piglets. The goal of vaccine development was addressed by three specific objectives:

- Reduce disease in piglets. The meningitis and poor viability in weaned pigs is particularly disturbing to barn staff and expensive for all producers who want healthy, vigorous stock.
- Compare death loss in vaccinated and control litters. Comparison of the effect of treatments will indicate the potential value of this vaccine to control this widespread disease.
- Measure antibody in colostrum. This measurement serves as a further explanation of how the benefits of vaccination occur.

Experimental Procedure

The strains of *Streptococcus suis* used for vaccine production originated from different pigs in the same herd with systemic disease. The strains were stored frozen at -70°C in infected spinal cord until used to produce the vaccine. These strains were serotype 3 and serotype 9.

The subunit vaccine was prepared from *Streptococcus suis* that were grown under special conditions designed to duplicate the environment experienced during an infection in a pig. This was designed to cause the production of antigens that are most important for the production of a protective immune response.

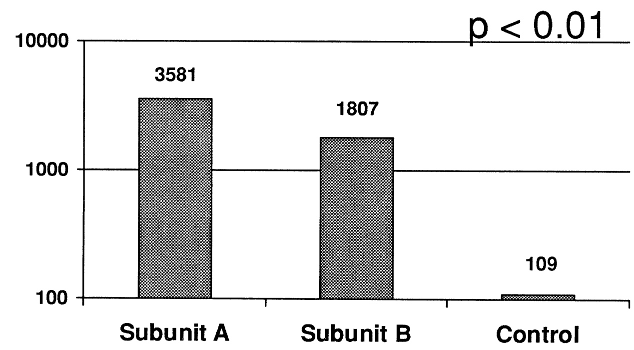
All colostrum samples were titrated in an ELISA (to measure antibody that reacts) against the *S. suis* extracted antigens. The titre of the colostrum was determined to be the highest dilution giving an absorbance greater than the mean plus one standard deviation of the background wells. Background wells contained no colostrum.

Sows were randomly (balanced for parity) allocated to one of three groups and vaccinated twice at one month and one week before farrowing. Sows in the three groups were given one of two subunit vaccines or an antigen-free control. The effect of vaccination was determined by measurement of the amount of antibody present in sow colostrum, and the amount of *S. suis* disease in piglets from vaccinated and control litters.

Results

The level of anti-*Streptococcus suis* antibodies in the colostrum of sows and gilts vaccinated with subunit vaccine was significantly ($P < 0.01$) greater than the titre in the colostrum of those given the control. This indicates that sows do not develop effective immunity just from the *Streptococcus suis* bacteria that are naturally present in the herd. Also this confirms that vaccination with the subunit vaccine has a major impact on colostrum antibody levels.

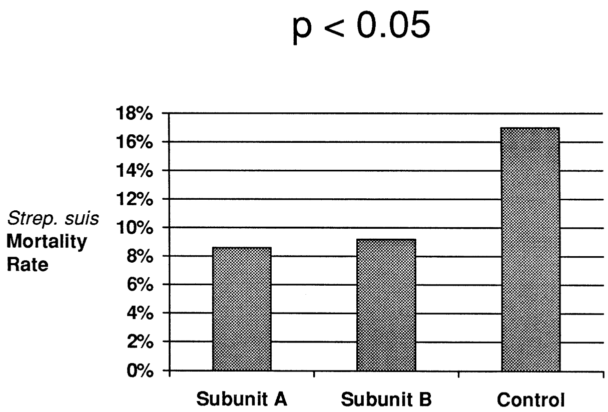
Figure 1. *Streptococcus suis* Antibody Titre in Sow Colostrum.



Since the vaccinated sows had higher colostrum antibody titres than controls, it was expected that their piglets would also have higher antibody titres than piglets nursing control sows. The titres in the serum from a sample of piglets nursing sows that had been vaccinated with subunit vaccines A or B were significantly ($P < 0.05$) greater than the titre in piglets that suckled control sows. This confirms that antibody was transferred to nursing piglets.

The greater antibody titre in vaccinated sows was translated into reduced mortality for their piglets. Piglets from sows vaccinated with either subunit A or subunit B had a mortality of 9%; whereas those in the control group had a mortality of 17% due to *Streptococcus suis* diseases as shown in Figure 2.

Figure 2. *Streptococcus suis* death loss in vaccine groups.



In order to ensure that this beneficial effect was due to increased sow immunity, we also compared the death loss in litters from sows with low colostrum antibody titres with the death loss in litters from sows with high antibody titres. The death loss due to *Streptococcus suis* in piglets from sows with a colostrum antibody titre greater than 500 was only about one third of the loss in litters nursing sows with lower antibody titres.

Finally we checked the age at which piglets died to see whether piglets from vaccinated sows were just dying later. Of the piglets which died from *Streptococcus suis* diseases, those from the control group died at an average age of 51 days, vaccine subunit A piglets died at an average age of 45 days and vaccine subunit B piglets died at an average age of 52 days. The slight differences in age when death occurred were not significant ($P = 0.16$). Therefore the subunit vaccines truly reduced disease in this herd.

In conclusion, vaccination with *Streptococcus suis* subunit vaccine increased the antibody titre in the colostrum of vaccinated sows and gilts. This passive protection was passed to nursing piglets and resulted in lower piglet mortality.

This experimental *Streptococcus suis* vaccine was shown to be an effective tool for control of disease in this herd. This information will lead to future development of commercial vaccines that will provide swine producers with a tool to control this devastating disease.

ACKNOWLEDGEMENTS

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EFFECT OF VENTILATION SYSTEM DESIGN ON THE AIRFLOW PATTERN AND CONTAMINANT DISTRIBUTION IN A SWINE BUILDING

Wenyin Li, Yuanhui Zhang and Ernest M. Barber

Summary

Proper distribution of air in a ventilated barn is important in order to achieve satisfactory temperature and air quality in a swine barn. To design an effective contaminant control system in a conventional-flow type of swine barn, an understanding of airflow is most important. In this project, the FLUENT computer model was used to simulate the airflow pattern and ammonia concentration in a grower-finisher room. The predicted airflow was a three-dimensional pattern. The three-dimensional flow structure, the contaminant concentration and temperature at the human breathing line (1.6 m above the floor) were highly affected by the combined jets which were composed of a ceiling inlet jet and a recirculation slot jet. The placement of the ceiling inlet and the recirculation duct affected airflow patterns, but had only a slight effect on the distribution of velocity, temperature and ammonia concentration along the human breathing line. Increasing the flow rate of cleaned recirculation airflow resulted in a lower ammonia contaminant level along the human breathing line. However, higher flow rates of cleaned recirculation air meant there would be higher fan operation and air cleaning costs. The optimum ratio of the ventilation rate to the cleaned recirculation rate appeared to be approximately 1:4.

Introduction

Several factors influence airflow pattern and contaminant transport in mechanically ventilated livestock buildings. These include the configuration of the ventilation system, ventilation rate, the location and structure of air inlets, the conditions of the incoming air, building size and shape, enclosure design, and heat and moisture production by the animals (Randall, 1975). These factors may also affect the contaminant transport inside the building. The contaminant transport is also affected by the generation rate of contaminants and the location of the contaminant sources.

Previous studies have focused on the simulation and experimental investigation of the airflow pattern and contaminant concentration distribution in a two-dimensional airspace (Nielsen et al., 1979; Timmons et al., 1984; Choi et al., 1992; Krause and Janssen, 1990; Maghirang et al. 1992; Zhang et al., 1992). These studies tried to simulate the ventilated space with a continuous slot (opening in ductwork) located at one side wall, and the exhaust fans installed on the opposite side wall. Due to the limited number of exhaust fans used, the three dimensional effects on the flow pattern and contaminant distribution were not accounted for in such two-dimensional studies. Few studies considering a three-dimensional airflow pattern and contaminant distribution in a livestock building have also been conducted (Hoff et al., 1993; Harral and Boon, 1993; Christensen, 1993). However, these three-dimensional studies only investigated the flow pattern and contaminant distribution in an empty room with only fresh air diffusers (vent covers with fins for diffusing air). The effect of a recirculation air system on the flow pattern was not considered then.

In the present project, the FLUENT CFD model was used to determine the effect of the ceiling inlets and the design of the recirculation system on the pattern of airflow in a grower-finisher room fitted with a ventilation system using discontinuous ceiling inlets combined with discontinuous recirculation-assisted slots. The effects of the placement of slots and the filtered recirculation airflow rate on the airflow field and the contaminant distribution were also investigated.

Building description

The floor plan of the swine barn is shown in Figure 1. This facility represented the full-scale grower finisher room (Engineering Room) at Prairie Swine Centre. The interior dimensions of this room are 14.3 m x 11.0 m x 3.0 m. It has 12 pens, 6 on each side of a middle alley connected with a door to a side corridor.

Twelve ceiling-inlets (MacKay MGM Air Inlet) were installed above the inspection alley in two rows. The distance between the exit side of two row inlets was 1.6 m. The inlet dampers were hung at ceiling level on the alley side, directing the fresh air by an attached jet toward the side walls. Two recirculation ducts were hung under the ceiling inlet. The recirculation air was sucked in by a fan installed at one end of each recirculation duct. The air was discharged through the discontinuous slots opened at the side wall of the duct. The discharged recirculation air traveled parallel to the ceiling surface and toward the side wall of the room.

A negative pressure ventilation system was used in the test room. Four exhaust fans were installed in an end wall opposite the door. Winter ventilation was provided only by a variable speed fan (Del-Air J-16). Fully slatted floors were made of concrete elements with module dimensions 53 cm by 122 cm. The porosity of the slatted floor is approximately 20%. The manure pits are 122 cm wide and 61 cm deep.

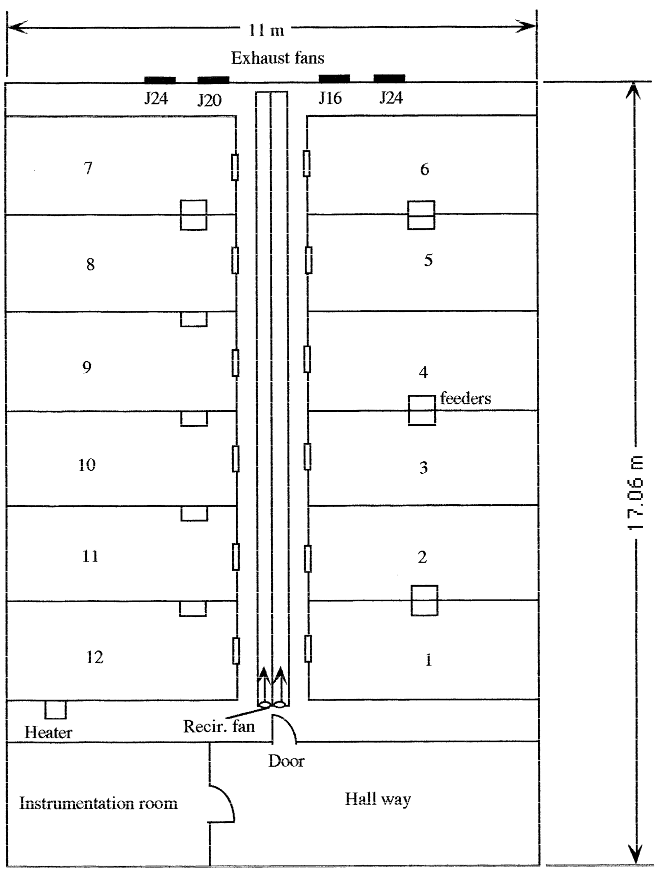


Figure 1 The floor plan of the grower-finisher room and adjacent areas

Numerical model

For the present project, the chilled air entered the warm room through the ceiling inlet. The flow was largely affected by buoyancy forces and the flow also was affected by the behavior of the combined jets. The turbulence model used in this project was the k-e model. The model includes buoyancy effects caused by temperature difference, not only on the mean momentum equation in the vertical direction, but also on the equations of turbulent kinetic energy and kinetic energy dissipation.

FLUENT solves the governing partial differential equations for the conservation of mass, momentum, energy, contaminant and turbulent characteristics k and $_e$ in a general form as:

$$\frac{\partial(\rho U_i \phi)}{\partial x_i} = \frac{\partial}{\partial x_i}\left[\Gamma_\phi \frac{\partial \phi}{\partial x_i}\right]$$

Results and Discussion

Airflow pattern is very important to air distribution in a room. The inlet location and the conditions at the inlet can affect the airflow pattern significantly. In the present study, fresh air flowed into the building through the discontinuous ceiling inlets, and recirculation air flowed into the air space through the recirculation slot just under each ceiling inlet. Two air jets flowed horizontally toward the side wall. At some locations, the two jets merged into one air flow stream. The combined jet provided momentum to the other airspace and formed a large rotary flow region just under the jet region. The behavior of the combined jets can affect the airflow pattern and other variable distributions across the entire air space of the room.

Figure 2 presents the profile of the velocity component in the z-direction at the middle cross section of pen No. 10 (Figure 1). The figure clearly shows how two jets develop along the jet region and combined into one final jet. At location 2, there is only one recirculation jet. At location 3, the ceiling air jet flows into the room through the ceiling inlet. There is a low velocity profile region between two peak velocity points. Two jets start to expand from where they originally entered the air space. At locations 4 and 5, the two jets expand along their flow direction and start to merge. At location 6, the two jets are completely merged together and its behavior is as a single jet. However, such combined jet behavior still depends on the behavior of the two original air jets.

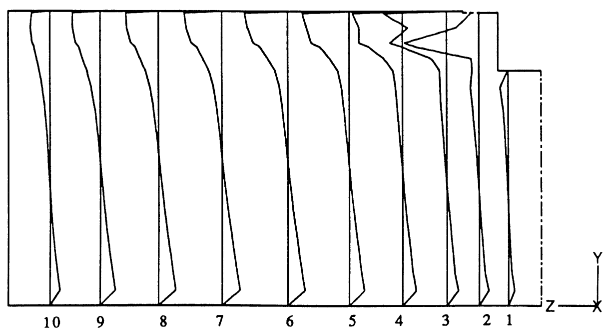


Figure 2 Velocity profile at the middle of the cross section of pen No. 10
(Velocity range = -0.58-2.66 m/s)

Effect of different flow rate ratios

Figure 3 represents the airflow patterns for two cases across the x-z planes (y=1.5 m). The figure shows that the different combination of the ventilation and the recirculation rate scan affect the airflow pattern in the room significantly. For case A (Figure 3a), there were three rotary flow zones, while case B (Figure 3b), had two rotary flow regions. These two regions were symmetric along the middle section of the room.

Further investigation showed that increasing the ventilation rate resulted in decreased ammonia concentration in the airspace of the swine building, while increasing the recirculation rate did not affect the ammonia concentration in the swine building.

a) Case a (Velocity range = 0~0.75 m/s)
Q_V= 0.25 kg/s and Q_R= 0.9 kg/s

b) Case b (Velocity range = 0~0.52 m/s)
Q_V= 0.25 kg/s and Q_R= 0.45 kg/s

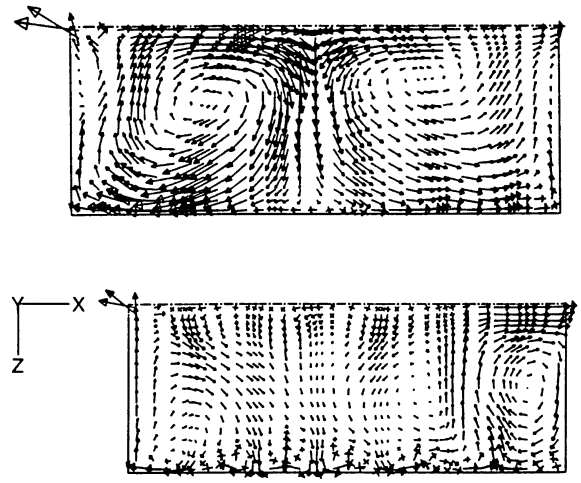
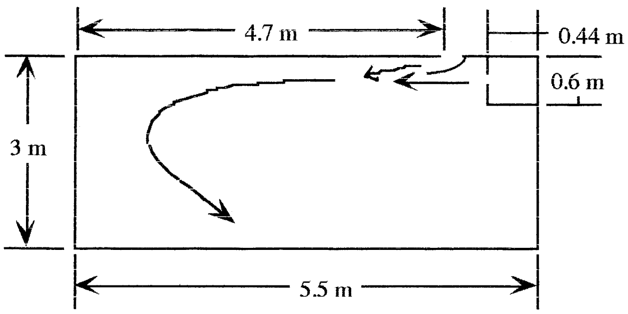


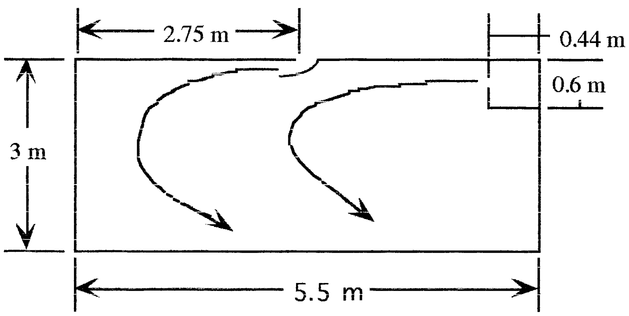
Figure 3. Airflow pattern

Effect of slots placement

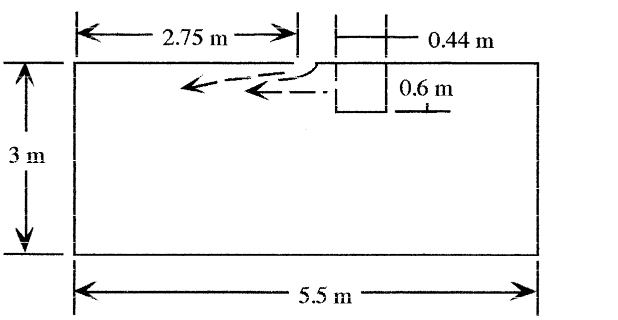
Several factors can affect the airflow patterns in swine buildings. One of the most important factors is the location of the inlets. In a cold climate, a recirculation system is often used to distribute air. Different arrangements of air inlets and recirculation air systems would result in different airflow patterns. In this subsection, the effect of slot placement on the airflow pattern and contaminant was investigated. Three different arrangements of inlets and recirculation slots were considered (Figure 4).



(a) Arrangement 1

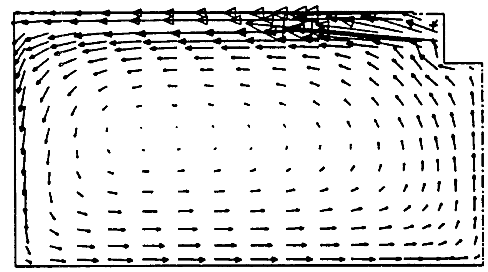


(b) Arrangement 2

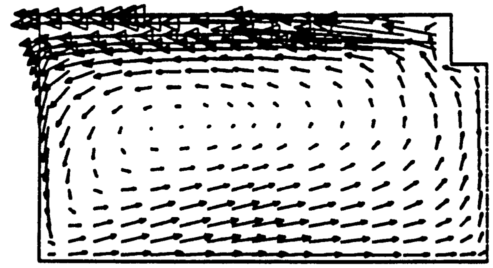


(c) Arrangement 3

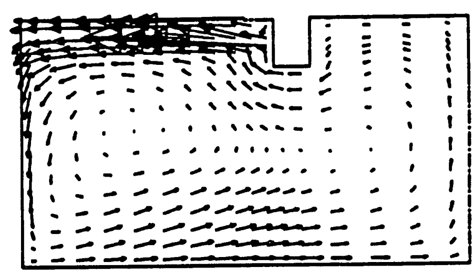
Figure 4 Arrangement of slot inlets



5a) Arrangement 1 (Velocity range = 4.42m/s)



5b) Arrangement 2 (Velocity range = 3.78 m/s)



5c) Arrangement 3 (Velocity range = 4.55 m/s)

Figure 5. Airflow patterns with different slots placement

Figure 5 presents the airflow patterns at the middle of the cross section of pen No. 10 for three different arrangements. Due to the deflection of air through the recirculation duct, the flow patterns near the ceiling surface for arrangement 3 were quite different from those for arrangements 1 and 2. There were two flow zones for arrangement 3. The zone at the left side of the recirculation duct had a higher rotation strength than that of the zone at the right side of the recirculation duct. This was due to the two air jets initially discharged into the left side flow zone. The flow patterns for arrangement 1 are similar to that of arrangement 2. However, the center of the rotary zones were different.

Figure 6 represents the profile of ammonia concentration along the human breathing line (approximately 1.5 m from the floor surface) for the three different arrangements of the ceiling inlet and the recirculation duct. The figure shows the placement of the inlet and the recirculation duct has a slight effect on the distribution of ammonia concentration along the breathing line.

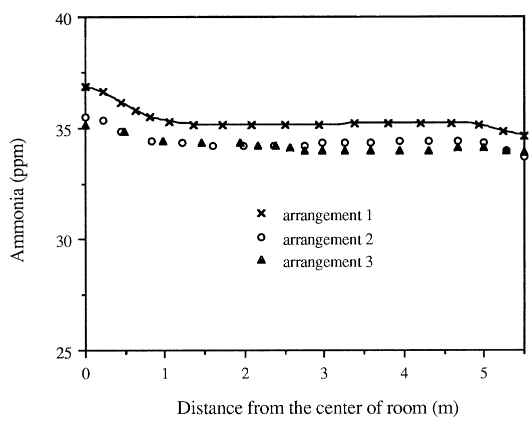


Figure 6 Effect of arrangement on the ammonia concentration along breathing line

Effect of flow rate of cleaned recirculation air

Figure 7 shows the ammonia profiles along the human breathing line at the middle cross section of pen No. 10 for a different combination of ventilation rates and cleaned recirculation airflow rates. Three different combinations of ventilation and recirculation rates were used. The concentration of ammonia at the recirculation slot was 37 ppm for uncleaned recirculation air, and zero for cleaned recirculation air. Figure 7 indicates that cleaned recirculation air dramatically decreases the air contaminant along the human breathing line. The figure also shows that a higher flow rate of cleaned recirculation air results in a lower ammonia contaminant level along the human breathing line. However, increasing the flow rate ratio above 3.6 did not decrease the contaminant significantly. A higher cleaned recirculation rate caused a higher recirculation fan operation cost and air cleaning cost.

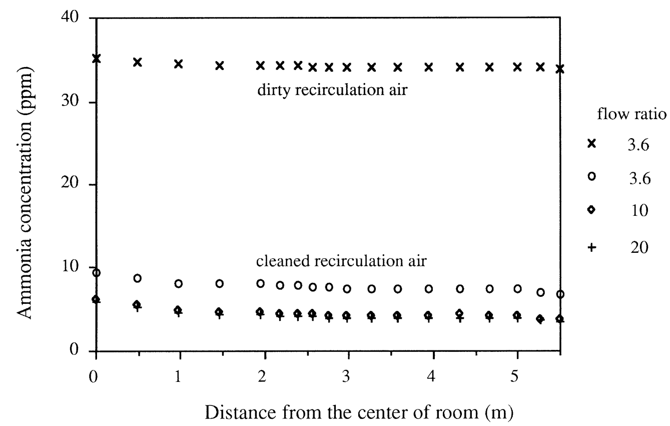


Figure 7. Effect of the placement of inlet slots on the ammonia contaminate distribution along the human breathing line.

Conclusions

The main purpose of this project was to numerically study the effect of the ventilation system design on the flow pattern and the contaminant distribution. The following conclusions were drawn based on the results presented here:

The predicted velocity profiles showed that after traveling a certain distance, the fresh air jet and recirculation air jet could be assumed as a single combined jet which behaved similar to a single air jet.

Different combinations of ventilation rate and recirculation rate affected the airflow pattern and other contaminant distributions along the human breathing line. Increased ventilation rates resulted in decreased ammonia concentration in the air space of the swine barn, while the recirculation airflow rate had no effect on the ammonia concentration.

The placement of the ceiling inlet and the recirculation duct had no significant effect on the profile of the ammonia concentration along the human breathing line, but did affect the airflow pattern.

Increasing the flow rate of the cleaned recirculation air resulted in decreased ammonia concentration along the human breathing line. The optimum flow ratio of ventilation rate to the cleaned recirculation air rate was about 1:4.

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HOW ANIMAL HANDLING INFLUENCES ANIMAL BEHAVIOUR

Harold W. Gonyou

Introduction

Animal handling is a part of all animal production systems. There is, however, considerable variation in the frequency and the purpose for animal handling. Dairy cows, for example, are routinely handled twice a day for milking, while beef cows may only be handled a few times per year. Movement from one pasture to another represents a simple form of handling. Restraint and upending in a tilt squeeze is closer to the other extreme. Nevertheless, all types of handling involve controlling the behaviour of the animal in some way. This review will discuss some of the features of animal handling and handling systems. A comprehensive review of animal handling has recently been published (Grandin, 1993a), including a chapter on the behaviour principles of handling (Gonyou, 1993). The reader may wish to consult those publications for more detailed discussion of the topic.

Goals of Animal Handling

Animal handling involves moving animals, applying a physical treatment, or both. Animals are typically restrained in some way during the application of the treatment. Most procedures involve both movement and restraint, and so it is necessary to not only initiate locomotion, but also to stop it. For example, weighing an animal usually involves moving it to a weigh scale, restraining it on the scale, and then moving it back to its pen.

The benefits of any handling procedure must be weighed against its costs. The economic costs of handling include labour, facilities and equipment, and productivity losses. In addition to the economic costs, handling involves an ethical component related to the stressfulness of the procedure. We should be prepared to increase the cost of facilities, equipment and labour if, by so doing, we reduce the stressfulness of the procedure.

The Problems of Animal Handling

As indicated earlier, animal handling involves control of the animals' behaviour. The problems involved in animal handling are not primarily physical, but psychological. Physical means are used only to induce the appropriate behaviour response.

How we (humans) communicate or should communicate with animals is poorly understood or developed. Some signals appear to have an intrinsic value. Pigs are less fearful of squatting than standing humans (Hemsworth et al., 1986). Dogs naturally respond to short, repeated rising notes with more activity than to long descending notes (McConnell, 1990). Being aware of such signals, and gaining understanding of these signals, is part of the process of turning stockmanship from an art into a science. More complex communication is possible as with voice or physical commands given to a horse, a dog or a dolphin, but it is based on extensive training.

One of the greatest challenges in handling animals is to avoid fearful reactions. The transition of an animal from being calm and easy to handle, to being frightened and out of control can be rapid. And once frightened, it is difficult to return an animal to a manageable state. Although fear is a potent means of moving an animal, it is counter-productive when it comes to regaining control to direct that movement or restraint. Keeping animals in groups as much as possible is one means of controlling fear, which is often induced by isolation in unfamiliar surroundings.

Components of an Animal Handling System

For the purposes of this discussion I will consider animal handling systems to consist of facilities, equipment, and personnel. Facilities are more or less permanent or fixed structures and are generally used to handle groups of animals. Equipment is more portable, is generally used to handle individual animals, and is often specialized in terms of treatments applied.

Facilities

Handling facilities are generally designed to facilitate movement of groups of animals. These include alleys, crowding pens, chutes etc. Facilities should be designed to facilitate movement in the desired direction, and prevent animals from turning back. Personnel may be able to physically control the movement of individual animals, but flocks or herds are best controlled by well designed and constructed facilities. Part of maintaining control over the animals is to reduce distraction by irrelevant stimuli. Solid walls should be used along all passages animals are to be moved along.

Animals move best in groups if they are able to maintain social contact. More animals can be moved down an alley that is the width of 3-4 animals, than through a single chute (Hutson and Hitchcock, 1978). Movement is also facilitated if animals are moving slightly uphill and toward a well lit area. Preventing the reversal of animals involves keeping the forward path open, and closing the return. A common error in the design of facilities is the failure to include gates or panels to prevent the return of animals to their pen should they escape past the handler. A second problem is that handlers fail to make use of these gates. Such an escape not only requires returning to the pen to start over, it also raises the excitement level of the animals, making them susceptible to fear.

Although wide alleys are usually more efficient to move animals, it is possible for animals to turn and reverse direction. Animals are particularly likely to do this when there is a point of transition in the environment. For example, the movement from a room into a hallway, around a corner, from one floor surface to another, or from outside into a weigh shed, are all likely to cause animals to hesitate, bunch up, and attempt to turn. In situations such as these, it is better to use a single file chute (Hutson and Hitchcock, 1978). The chute should allow animals to maintain visual contact with the animal ahead, through the use of gradual curves rather than corners. If animals must pause in a chute, as when waiting for another animal to be processed in a squeeze or scale, some provision should be made to prevent backing up. Permanent boards placed at hock height allow sheep to step over them while moving forward, but deters backing up (Hutson and Butler, 1978). Bars at hip level are often placed behind cattle as they are held in a chute. Narrowing the bottom of the chute deters animals from trying to turn around even if the chute is too wide to prevent turning.

Although handling facilities are a critical part of any livestock system, they are often overlooked during the design process. Hallways and holding pens are rarely designed with the animal in mind, and the need for retrofitting buildings is great. Part of the reason for this is the difficulty in conducting necessary research. Facilities are expensive, and a factorial study of facility design would be costly. The greatest research effort on handling facilities has been that on sheep in Australia (e.g. Hutson, 1980). Van Putten and Elshof (1978) studied various features of handling facilities for pigs. Much of our knowledge about livestock handling has been derived from consultants while working on projects (Grandin, 1993b)

Equipment

Equipment may be hand-held or fixed in the facilities, but is generally used to handle individual animals. When moving pigs it is very useful to use a herding board. This solid wood or plastic device can be used to close an opening if the animal tries to escape past the herder. Although buggy whips or canes have traditionally been used for the same purpose for cattle, a broomstick with a pom-pom on the end is more effective as a visual tool.

Equipment is often used to restrain animals. Cattle squeezes need to be properly designed to hold the animal while it is being worked on. Scales should be placed well inside the building so that they are not part of the transition of entering from outside. Restraining equipment must be strong enough to withstand the escape attempts of the largest animal.

The use of some equipment is aversive to animals. Occasional shocks from an electric prod can affect the productivity of pigs (Gonyou et al., 1986). Sheep form a strong aversion to the electric immobilizer (Rushen, 1986). The use of such aversive techniques continues to be debated. It is argued by some that electro-immobilization of deer is less stressful because of its effectiveness, than conventional restraint which results in considerable thrashing about. The answer to this debate will require testing in specific species. Whatever the outcome, it would appear that better restraint equipment is needed for non-traditional livestock.

Personnel

The most important part of a handling system are the persons who handle the animals and operate the facilities and equipment. Hemsworth (1994) advocates a training program for all stockpersons which emphasizes the effects poor handling can have on animal productivity and welfare. Personnel need to be familiar with animal behaviour, and be able to recognize an animal before it turns back or attempts to escape. The potential of well designed facilities and equipment will only be realized if the stockpersons use them properly. But perhaps the greatest attribute for a stockperson is patience. Over-reaction by handlers is one of the most common reasons for animals to become frightened or to try to escape.

The risk of poor stockpersons handling livestock, as well as labour costs, has contributed to the development of mechanized handling systems. The Australians have developed mechanized shearing. Also, milking robots allow cows to be milked without human contact. The Danes have developed a mechanized system of moving pigs through the holding pens in slaughterhouses that avoids the excitement caused by handlers. The result is fewer quality problems in their pork. Although we may cling to the idea that stockpersons are loved by their animals, the consistency of robotic systems may ultimately result in better handling.

Conclusions

Handling is an important part of any livestock operation. The costs of poor handling remain hidden as relatively little research has been directed to this area. Understanding the reaction of animals to their environment is a critical part of improving handling and requires continued research on animal behaviour. Efforts in this area will not only yield economic rewards, but will also improve the welfare of the animals.

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