Highlights
in Canadian Dairy Cattle Research

2008

Dairy Farmers of Canada

Les Producteurs laitiers du Canada

Réseau laitier canadien

Canadian Dairy Network

Agriculture and Agri-Food Canada

Agriculture et Agroalimentaire Canada

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Introduction

Canada has more than 16 main research institutions, with some 150 researchers doing scientific work connected with dairy production. This research yields a large amount of information essential to the growth and profitability of Canada's dairy industry. This information is disseminated in scientific journals that are often little known to and little used by dairy producers. The Dairy Farmers of Canada (DFC) and the Canadian Dairy Network (CDN) together asked, on behalf of Canadian dairy producers, that a document be developed to inventory the results of the research funded by all Canadian dairy industry partners. The purpose of this document would be to make the results published in the scientific journals accessible to as wide an audience as possible within the dairy industry.

First, we identified from last year's researchers list, the scientific articles published for the period of September 2006 to September 2007. Then we wrote a short abstract in non-technical language for each of the articles, which we grouped into various categories: animal welfare, environment, genetics, health, herd management, milk production, nutrition and reproduction. Once the abstracts had been written, we contacted the corresponding author or a collaborator when the first author was unavailable to obtain their approval of the information. The necessary modifications were made.

This document is meant to showcase the results of research published by our Canadian researchers and to encourage Canadian industry stakeholders to consult the various scientific journals. With a view to proper interpretation of the results, each article includes a complete reference. Thus, you will be able to use the additional information to access the scientific articles for a better understanding of the research results. Copyright in the scientific articles cited in the document remains the property of the various scientific journals. The document has been revised by Réjean Bouchard, Ph.D, of the DFC, Brian Van Doormaal of the CDN, and Jacques Surprenant, Ph.D, of Agriculture and Agri-Food Canada (AAFC).

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1 Animal Welfare

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Stress on calves is often measured by taking blood samples and measuring the concentration of certain hormones (such as cortisol) that increase during times of stress. However, usually this is done by taking one or a few blood samples and taking average values of hormone concentrations. However, hormones are released in a pulsatile manner. Furthermore, other hormones (such as growth hormone) are also affected by stress. Researchers used new, sophisticated statistical techniques to measure the pulses of both cortisol and growth hormones in calves that were housed on concrete floors rather than the usual rubber mats, and which were relocated to a new room (both known to cause stress to calves). These new statistical techniques were much better at describing calves' hormonal responses to stress and show great promise for improving our ability to measure stress in cattle.

2 What components of milk stimulate sucking in calves

Applied Animal Behaviour Science, December 2006, Volume 101, Number 3-4, pages 243-252.

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When calves are raised in groups, they often suck at each other causing injuries. A better understanding of the sucking motivation in calves is needed to identify means of satisfying and controlling sucking when it is misdirected. Scientists have demonstrated that calves often cross-suck each other after their milk meal. They studied dairy calves between 4 and 18 weeks of age to examine what components of milk stimulate sucking. After drinking a small quantity of milk (natural or reconstituted), the animals were given a dry teat and their sucking behaviour was observation. The concentrations of the casein, whey protein, lactose and fat of milk were varied and these special test samples of milk were fed to the calves directly into their mouth. An increase in the lactose concentration of the milk resulted in the calves sucking more, while a decrease in lactose concentration resulted in the calves sucking less. No increase or reduction of the concentration of any of the other components had any effect on calf sucking. The use of lactase (to break down the lactose) did not effect the sucking. In conclusion, the taste and sweetness of milk are the factors in milk that stimulate sucking in the calves after their milk meal. Milk protein and fat have little effect on that behaviour.

3 Identifying and preventing pain in animals

Applied Animal Behaviour Science, October 2006, Volume 100, Number 1-2, pages 64-76.

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Pain in animals may be caused by standard farm practices (e.g. castration, dehorning, etc.) and disease (e.g. tumours, ulcers, injuries, etc.). In this review the authors illustrate different techniques to identify and evaluate pain. The review also documents various approaches to avoiding and reducing pain.

4 Calves' behaviour during nursing is affected by feeding motivation and milk availability

Applied Animal Behaviour Science, December 2006, Volume 101, Number 3-4, pages 264-275.

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In order to study the relationship between the sucking behaviour of young calves when nursing from their dam and their actual milk intake, the suckling behaviour of 10 dairy calves was observed between birth until 9 weeks old in a series of behavioural tests. The amounts of milk that was available in the udder of the dam was varied by the way the cow was milked just prior to the nursing to examine how milk availability could affect the calves' sucking behaviour A reduction in milk quantity resulted in more sucking, due to more frequent and shorter bouts of sucking. Lower milk availability also stimulated the calves to butt at the udder and switch teats more frequently to try and obtain more milk. When more milk was available in the udder, calves did less sucking, butting and teat switching, even though they did not drink more milk, suggesting that a low flow of milk may be a factor frustrating the calf. The amounts of milk calves were fed before or during a nursing was varied to examine how appetite can affect sucking behaviour. When calves were hungry they sucked for longer on the dam and they ingested more milk. On the contrary, calves that were more sated sucked less and ingested less milk. The study concludes that calves' sucking behaviour during nursing does not predict the quantity of milk they drink. However, butting and switching teats are indicators of low milk availability and hunger.

5 Effects of pasture on lameness in dairy cows

Journal of Dairy Science, March 2007, Volume 90, Number 3, pages 1209-1214.

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Lameness of animals is a major issue in dairy production, and a cause of pain and discomfort for cows. This study tested the effects on gait of allowing lame cows access to pasture. Eighteen groups, each of 4 lactating Holstein cows, were randomly assigned to housing either in a free-stall barn or on pasture. Cows were gait scored weekly for 5 weeks using a 1 to 5 score. Relative to the cows housed indoors, cows on pasture improved by a full gait score (i.e. from 3 to 2) over the treatment period. Two specific elements of gait, tracking up and reluctance to bear weight evenly on all 4 hooves, also improved. There was no change in two other specific gait elements (head bob, back arch). Cows on pasture also spent less time lying down than did cows kept indoors. The study concludes that lame cows benefit from spending even relatively short periods of time (i.e. > 3 weeks) on pasture.

6 Softer, higher-friction flooring improves gait of cows with and without sole ulcers

Journal of Dairy Science, March 2007, Volume 90, Number 3, pages 1235-1242.

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Concrete flooring is very common in dairy barns because it is easy to clean, durable and inexpensive. One major problem of concrete flooring is that it represents a risk factor for the development of lameness, hoof diseases, whiter line hemorrhages, sole ulcers, digital dermatitis and heel erosion. In this study, researchers studied 30 dairy cows in order to evaluate their gait on concrete and a soft, high-friction rubber flooring. After 9 weeks in the experiment, the cows had their hooves trimmed to see if they had sole ulcers or not. Video recording of the cows walking around were used in slow motion to analyze their stride. Gait was also evaluated on a scale from 1 (good) to 5 (severely lame). It was found that, no matter if the cows had sole ulcers or not, those walking on the rubber flooring had a better performance compared to the cows walking on concrete. Cows having the most severe degree of lameness displayed the greatest improvement when they were walking on the rubber flooring, compared to the cows having a better gait. The study concludes that rubber flooring is a better surface than concrete in regard to security and comfort of the animals, especially of lame cows.

7 Short communication: Usage of mechanical brushes by lactating dairy cows

Journal of Dairy Science, May 2007, Volume 90, Number 5, pages 2241-2245.

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Grooming is a natural behaviour of farm animals. Using their tongues, feet, horns and tails, cattle routinely perform grooming as a mean to clean and groom the areas of their body that they can reach. Some parts, however, are out of reach and this is why these animals make use of trees, fences, posts, walls, etc to scratch their bodies. In this study the researchers compared the frequency and duration of scratching behavior of 72 dairy cows, split into 6 groups of 12 cows, in the absence of a brush and when provided with a mechanical brush. It was found that, less than 24 hours after the installation of the mechanical brush, nearly 60 % of the cows had utilized it. Less than a week after the installation, 93 % of the cows were scratching themselves on the brush, and at the end of the experiment, all the cows except one were using the brush. Compared to the control group, the cows that had the brush scratched themselves more frequently (226 % more times) and for longer period of time (508 % longer). While the cows could still use their tongues, feet, and tails for scratching, they preferred to use the brush; utilizing this tool for over 91 % of the total scratching time and almost 80 % of the total scratching events. These results demonstrate that providing a mechanical brush helps dairy cows feel more comfortable as they can easily scratch their body even in areas that would be difficult to reach. Facilitating this natural behaviour may also reduce stress and boredom these animals experience while in free-stall barns.

8 Maternal behavior in cattle

Hormones and Behavior, June 2007, Volume 52, Number 1, pages 106-113.

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This review provides a critical summary of the scientific literature on maternal behavior in cattle. When domesticated cattle are rearing their young, the behaviors associated with maternal care are for the most part similar to those observed in wild ruminants. These behaviors allow the cow to bond with her calf, protect and provide the calf with nourishment, and the bond is ultimately severed at weaning. Beef and dairy production systems have emphasized different maternal behaviors. For example, most beef cattle production systems place the responsibility of rearing the calf largely on the cow and risk factors that affect the maternal bonding process (e.g. cross licking) remain important practical challenges. In contrast, most dairy cattle production discourages all aspects of maternal behavior with the exception of milk production, but changing consumer demand (e.g. increases in organic production) will make an understanding of maternal behavior in this system a priority in years to come.

9 Prepartum behavior and dry matter intake identify dairy cows at risk of metritis

Journal of Dairy Science, July 2007, Volume 90, Number 7, pages 3220-3233.

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Metritis is a uterine infection that occurs frequently after calving and is known to negatively influence reproductive performance. This study looked at behavior and intake during the period before calving to determine if these measures could identify those cows at risk for developing metritis after calving. A group of 101 Holstein dairy cows were monitored from 2 weeks before until 3 weeks after calving. An electronic monitoring system was used to record measures of feeding and drinking behavior and intake, and video cameras monitored social behavior. Metritis severity was determined based on daily records of rectal temperature and condition of vaginal discharge that was assessed every 3 days after calving until 21 days post partum. Overall, 12 % of the cows were classified as severely metritic and 27 % as mildly metritic. Compared to healthy cows, those animals that developed severe metritis spent less time eating and consumed less feed 2 weeks before clinical signs of infection were detected. During the week before calving the cows that later developed metritis engaged in the least amount of aggressive interactions at the feed bins and consumed less feed during the peak feeding times which occurred following the delivery of fresh feed. This study indicates that both prepartum intake and behaviour, particularly during the week before to calving, can identify cows at risk for developing metritis after calving. Further, this study is the first to show a relationship between social behavior before calving and health after calving.

10 Overstocking reduces lying time in dairy cows

Journal of Dairy Science, July 2007, Volume 90, Number 7, pages 3349-3354.

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Dairy cows have a natural behavior of lying down. About 50 to 60 % of their time is spent lying down and they can stay in that position up to 12 to 13 hours a day. This is important for their well-being as lying down reduces the risk associated to hoof health and locomotion problems, it also maintains normal cortisol and growth hormone concentrations. The objective of this research was to assess the effect of overstocking on the lying and standing behavior of dairy cows. Researchers worked with 4 groups of 12 cows/group. They provided freestalls in a ratio ranging from 12 stalls for 12 cows (one cow per stall), changing the stocking density by one stall intervals to 8 stalls for 12 cows (1.5 cow per stall). This ratio (8 stalls, for 12 cows) corresponds to an overstocking of 150 %. The cows stayed for a week in their overstocked environment and were then returned to a normal room having 100 % stocking ratio. The cows' lying and standing behaviour was measured, as was of the ability of the animals to displace other cows from the stall. The study concludes that there is a direct link between space availability and lying time. When overstocked, cows in freestall barns spend more time standing up, there is an increased rivalry for the stalls, and the cows spend less time lying down.

11 Effect of softer flooring in tie stalls on resting behavior and leg injuries of lactating cows

Journal of Dairy Science, August 2007, Volume 90, Number 8, pages 3647-3651.

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The type of flooring in a barn is an important aspect of dairy farming operations. To maximize milk production and to keep a good health, the cows must spend about 40 to 60 % of their time lying down. Previous research done on free-stall design has shown that cows prefer to lay down and rest on soft surfaces. For this study, researchers evaluated two type of flooring in a tie stall barn, and their impact on the cows' leg injuries. A total of 24 cows housed in a tie stall barn were evaluated in this study ; 12 were on concrete flooring and 12 others were on soft rubber mats. All of the 24 stalls were covered with a light amount of straw. Every 28 days, during the complete period of the experiment (112 days), the cows were observed without interruption for a period of 24 hours to assess their general activity. The cows' behavior was recorded every 14 days using a scan sampling technique so that each cow was observed for 3 minutes every 12 minutes. Lesions to the legs and other injuries were recorded every 7 days during the project. It was found that cows on rubber mats spent more time lying down compared to cows on concrete flooring. Also, they seemed more confident when changing position from standing to lying, and from lying to standing. The type of flooring had no impact on the time spent eating and on the minor lesions to the legs. However, cows housed on concrete flooring had a greater amount of swelling from the carpus joints. The study concludes that rubber mats may decrease the frequency of various leg problems.

12 Validation of two measures of lameness in dairy cows

Applied Animal Behaviour Science, August 2007, Volume 106, Number 1-3, pages 173-177.

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Lameness of cows is an important health issue in dairy farming, and it is not always easy to identify which animals have difficulty walking, especially when those animals are part of large herds. The purpose of this study was to evaluate two methods for detecting lameness in cows. The first method is gait scoring and the second is the use of a weight scale to read the weight displacement from one leg to another. Previous research has suggested that lame cows in standing position will remove weight on their injured leg by transferring body weight on the opposite (contralateral) leg. Furthermore, it was also found that lame cows frequently displace their body weight on contralateral legs. In this experiment, researchers recorded gait scores and weight transfer before and after they injected a local anaesthetic (lidocaine) to healthy and lame lactating dairy cows. It was found that, before injection of the anaesthetic, lame cows were transferring more weight from the injured leg to the contralateral leg, and they also had a higher gait score than healthy cows. After injection of the anaesthetic, the gait score of lame cows decreased and the animals reduced the weight transfer from the injured leg to the contralateral leg. The study concludes that the two methods of detecting lameness have some degree of validity.

2 Environment

1 Assessment of the Sulfur Hexafluoride (SF_6) tracer technique for measuring enteric methane emissions from cattle

Journal of Environmental Quality,
September-October 2006, Volume 35, Number 5, pages 1686-1691.

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Methane (CH_4) is an odourless and colourless gas naturally produced by ruminants as a result of food's microbial fermentation in the gastrointestinal tract. Most of the methane escapes the animal through the mouth (eructation and respiration) but there is also a smaller quantity that may escape through the rectum. Methane contributes significantly to greenhouse gases so it is important to have accurate and reliable measurements of that gas. One of the most common methods to measure methane is the SF_6 tracer method. However, this technique only measures gas coming out of the mouth and nose of the animal whereas the chamber technique collects and measures all the gases produced by the animal. The purpose of this study was to evaluate the effectiveness of the SF_6 tracer method compared to a chamber method and that, with different diets for the animals. In this experiment, eight beef heifers were either fed with high grain or high forage. This was done to vary the location of digestion in the intestinal tract. At one time, the animals could eat as much as they wanted and at another time, they had a restricted diet (65% of maximum intake). Measurements of the methane were made using both SF_6 tracer and chamber techniques. The results indicated that the SF_6 tracer method underestimated the methane emissions on average by 4% compared to the chamber method. That difference was not significant and suggests that a very small amount of methane actually exits the animal from the back. Furthermore, the study found that the SF_6 method is more accurate and reliable when the animals are fed with high forage at restricted intake. This leads to the conclusion that the SF_6 method is best suited for animals grazing pasture. For dairy operations with high grain diets, the method is suitable but with greater uncertainty.

2 Policy and technological constraints to implementation of greenhouse gas mitigation options in agriculture

Agriculture, Ecosystems and Environment, 2007, Volume 118, Number 1-4, pages 6-28.

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Like any other industrial sector, agriculture produces greenhouse gases that have a negative effect on the environment. Recent studies have demonstrated that there is an important potential for reduction of greenhouse gas emissions from the agricultural sector, but that there are also important barriers to total reduction. They also reported that less than 30% of the total reduction potential of greenhouse gases might be achieved by year 2030, because of financial and non-financial barriers to implementation. This study examined the factors that represents those barriers. Researchers from different regions of the world shared information to provide an overview of international climate and non-climate policies, and also to evaluate the past and future impact of those policies in regard to agricultural greenhouse gas emission and reduction. The study also describes and analyzes the development of climate and non-climate policies in selected foreign countries, and how those policies have affected or not the reduction of greenhouse gases from agriculture. The key to success is to develop creative policies that will bring benefits to all the aspects of the question: economic, environmental and social. It is concluded that sharing knowledge and innovative technologies with other countries will have a significant positive impact on land resources and the rational use of chemicals in agriculture.

3 Long-term effects of feeding monensin on methane production in lactating dairy cows

Journal of Dairy Science, April 2007, Volume 90, Number 4, pages 1781-1788.

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Monensin is a natural antibiotic that is used as a food additive for cows. It is approved and used in several countries (Canada, Brazil, Australia, Argentina, New Zealand, South Africa, United States) to control fermentation in the rumen of ruminants and, ultimately, reduce the emission of methane from the animals. However, some studies have shown that the effect of monensin may not last for very long and that, after some time of low gas production, methane emission eventually goes back to the level it was before feeding the monensin. This is why it was decided to study the long-term effects of monensin on the methane emission of lactating dairy cows. For the purpose of this project, researchers selected 24 lactating Holstein cows housed in a tie-stall building. They fed the animals ad libitum; a first group with a mixture of grass and a placebo mixture, and the other group with a mixture of grass and monensin. The cows were fed and milked twice a day. Methane emission was measured before the experiment and then, every month for the next 6 months. Readings indicated that there was a 7 % decrease of methane emission (in grams per day) and that this lower level stayed the same for the complete 6 months. There was also a 9 % reduction of milk fat and a 4 % reduction of milk protein. Monensin did not seem to affect other parameters. Findings from this study show that using monensin is an effective way of reducing methane emission from lactating Holstein dairy cows.

4 Some methodological and analytical considerations regarding the application of the gas production technique

Animal Feed Science and Technology, May 2007, Volume 135, Number 1-2, pages 139-156.

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Methane is a gas generated in large quantity by ruminants in their digestive track, mostly within the rumen. The quantity of gas generated by the animals depends on several factors: the animals' health condition, the type of food they eat, etc. To better study methane emissions from ruminants without disturbing the animals, simulation of the digestive process can now be made in laboratory (in vitro) and it becomes possible to evaluate different types of grass and grains, and the interaction of those grass and grains with different enzymes and bacteria. The information resulting from those laboratory experiments is then compared to measurements of methane coming out of the animals. The present study describes the development of mathematical formulae that can be used by scientists to estimate gas and methane emissions when feedstuffs are incubated in vitro with buffered rumen fluid to simulate what happens in the rumen itself.

5 Estimation of ammonia emissions episodes for a national inventory using a farmer survey and probable number of field working days

Canadian Journal of Soil Science, May 2007, Volume 87, Number 3, pages 301-313.

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The atmospheric release of ammonia and odour from agricultural operations is a well-known concern for the population and authorities. Ammonia is a toxic and irritant gas generated from manure. Estimation of ammonia release from manure is a difficult task because it varies a lot during the course of the 3 agricultural seasons (spring, summer, fall), depending on the operational planning of the farmers and, above all, weather and soil conditions. Researchers conducted a national survey, asking about 3100 Canadian livestock farmers about their agricultural activities. That information was used in conjunction with 30 years of weather data to establish different ammonia emission scenarios, from the best possible case (when both weather and soil conditions are good) to the worst possible case (when weather and soil conditions are so inclement that manure spreading is limited to very few days). The study concludes that spring and fall are the periods of the year when ammonia emission episodes can be up to 20-fold more intense because of spreading schedules and likelihood of inclement weather. The reason for this is because the weather and soil conditions restrict the number of days where farm activities can be performed. Therefore, in a specific region, if most farmers spread the manure in their fields in the same few days, the potential health effects may be more pronounced shortly after those periods.

6 Methane emissions from dairy cows measured using the sulfur hexafluoride (SF_6) tracer and chamber techniques

Journal of Dairy Science, June 2007, Volume 90, Number 6, pages 2755-2766.

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Accurate measurement of methane emissions from cattle is important because this gas has a negative impact on global warming. The most accurate method of measuring total methane emissions from dairy cows is to put them inside a closed chamber and take gas readings with electronic equipment. However, this method is complicated as it requires housing the cows inside a chamber. The sulfur hexafluoride (SF_6) tracer method is more convenient because it can be used with cows in their normal setting. On the down side, the tracer method is reported to give estimates of methane that are 93 to 95% of estimates obtained from animals in chambers. Also, the food given to the cows when they are inside those chambers is not always the same as what they eat when they are on pasture or in a barn. Cows on pasture select the grass they prefer to eat. In captivity, they eat what is in their manger. This is important because the main cause of methane emissions from ruminants is how much food is consumed and the digestion process it undergoes in the rumen. The objective of this study was to verify the accuracy of the tracer method. To do this, we used the tracer technique inside the closed chambers, and fed the cows a diet similar to what they typically ate. Sixteen lactating Holstein-Friesian dairy cows were used in the project. Each cow was confined in a closed chamber where total methane emission (including from the rectum) was measured using the SF_6 tracer gas equipment. To replicate the grazing situation, the cows were fed each day with fresh grass cut from a pasture nearby and the animals could eat as much as they want. Also, a supplement of grain was given to the cows daily. The study concludes that the SF_6 tracer method of measuring methane is reasonably accurate and can be used to estimate methane emissions for national inventory calculations and to assess mitigation practices aimed at reducing methane emissions from the dairy industry.

7 Prediction of methane production from dairy and beef cattle

Journal of Dairy Science, July 2007, Volume 90, Number 7, pages 3456-3466.

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Methane is one of the major greenhouse gases responsible for climate change and global warming. At the world level, agriculture accounts for about 20 % of the greenhouse effect while 50 % of total methane emissions come from human activities. The largest part of agricultural methane emissions come from the digestive fermentation process of ruminants, in particular beef and dairy cattle. Some mathematical models are now available to help researchers predict methane emissions without the need for expensive and time-consuming experiments. These models are either statistical, predicting methane production from a basic description of the diet, or dynamic mechanistic, predicting methane production from mathematical modeling of the rumen fermentation process. Even though mechanistic models have demonstrated an interesting level of accuracy in predicting methane production, they often rely on input variables that are unusual while other statistical and mechanistic models predict methane production only inside a specific range of values. In this project, scientists have developed several new methane prediction models that take into account the North American context (diets, bovine breeds). These new models proved to be easier to use and gave an adequate prediction accuracy using a minimum number of input variables. Their use is recommended for calculations of the national methane emissions inventory.

8 Sensitivity analysis of alternative model structures for an indicator of ammonia emissions from agriculture

Canadian Journal of Soil Science, 2007, Volume 87, Number 2, pages 129-139.

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Ammonia produced by agriculture, and especially by animal agriculture, is a health and environmental concern that is being addressed by many nations around the world. Ammonia is toxic to humans and vegetation; it also produces very fine particles in the air when mixed with other pollutants, and these particles are a potential health hazard. Canada has prepared a national inventory of ammonia emissions in order to prepare future policies and regulations. The challenge is to calculate ammonia emissions precisely, taking into account that Canada is a very large country having a high number and variety of different farm buildings, animals, geographical environments, farm practices, regional climates, etc. Several mathematical and computational models have been developed over the years to predict ammonia emissions and this study compared those different models. It was found that more recent and elaborate models that take into account the complete ammonia cycle, from animal excretion to storage and to its final use as a soil fertilizer, indicate that the best method to control emission may be to start with looking at protein in the diet. The study concludes that the factors contributing to ammonia emissions in Canada are not well known, and that further research should focus on identifying the causes that impact on the ammoniacal nitrogen excretion in particular.

9 Exposure of pregnant dairy heifers to magnetic fields at 60 Hz and 30 microT

Bioelectromagnetics, September 2007, Volume 28, Number 6, pages 471-476.

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Studies have shown that exposure of dairy cattle to electric and magnetic fields, such as those prevailing under high-voltage power lines (735,000 volts AC and 2,000 amperes), results in some moderate physical and behavioural changes in the animals: they eat more, have a higher milk yield, a higher concentration of progesterone in their blood plasma, and a higher length of estrous cycle. Since other research has demonstrated that exposure to electric fields did not only produce those changes, this study was conducted to discern if the magnetic field is the responsible factor. In this study, 32 pregnant heifers (aged about 21 months, weighing about 500 kg and having about 3 months of gestation) were divided in 2 groups of 16 heifers. Each group was exposed during a continuous period of 4 weeks to magnetic fields of 30 microtesla at 60 Hertz and a daily light cycle of 12 hours of darkness / 12 hours of light. Feed intake was measured every day and two blood samples were collected once a week to measure the amount of 4 key hormones: progesterone, melatonin, prolactin and insulin-like growth factor. The results of the study indicated that, after 4 weeks, heifers exposed to magnetic fields similar to those found under electric power lines had a slightly higher weight and weekly weight gain, with a smaller amount of prolactin and insulin-like growth factor in their blood compared to heifers from the group that was not exposed to magnetic fields. Since there were no visible and clinical signs of decline of the health of animals, the study concluded that exposure to high magnetic fields does not constitute a major health hazard to pregnant dairy heifers.

10 On-farm phosphorus budget: Model to predict yearly phosphorus contents in manure of dairy herds

Canadian Journal of Animal Science, September 2007, Volume 87, Number 3, pages 407–411.

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Intensive animal agriculture generates and releases an important quantity of phosphorus in the environment. This is a cause of pollution for waters of the province of Quebec. Improving some management practices can lead to a reduction of phosphorus emissions from farm operations. For example, animal diets can be designed to have lower phosphorus impact, both in the manure and in the fertilization of cereals. The objective of this study was to make an estimation of annual phosphorus production originating from manure using a model based on replacement and dairy cows. Researchers used records from the PATLQ (Programme d'Analyse des Troupeaux Laitiers du Québec, in English: Program for Analysis of Dairy Herds of Quebec). In April 2006, the PATLQ changed its name and is now called Valacta. Monthly records and yearly descriptions of 4614 Holstein dairy herds were studied for the period between 1999 and 2001, from 18 areas where phosphorus pollution was important. Samples of feeds harvested on those farms were collected monthly. Phosphorus in feed intake was measured for 1133 herds (years 2000 and 2001 only). After analyzing extensively the data and providing a series of correlations and non-correlations between the factors studied, the authors concluded that the accuracy of the model developed in this study is somewhere around 22 %. That level of accuracy is estimated to be acceptable, considering the difficulty of sampling and measuring phosphorus from manure stored in heaps.

11 Estimates of enteric methane emissions from cattle in Canada using the IPCC Tier-2 methodology

Canadian Journal of Animal Science, September 2007, Volume 87, Number 3, pages 459–467.

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According to studies, in 2001 the agricultural sector generated about 8.3% of the total greenhouse gases in Canada. Livestock are responsible for 48% of that quantity, of which 31% is attributed to methane emissions from enteric fermentation of feed. The objectives of this research were 1) to estimate enteric emissions of methane from Canadian cattle for the year 2001 using the International Panel on Climatic Change (IPCC) Tier-2 method, and 2) to compare data from phase 1 of this research with data from the IPCC-Tier 1 model and from Canadian research studies. Researchers found that when using the Tier-2 method, emissions for dairy cattle ranged from 708t yr^{-1} in Newfoundland to 62 184 t yr^{-1}in Ontario. In general, estimates for methane emissions made with the IPCC Tier-1 method were lower than those from the IPCC Tier-2 method. This is because the IPCC Tier-1 model does not take into account the differences in performance and feeding practices. The study showed that estimates of Canadian enteric methane emissions differ depending on the method used to calculate emissions: IPCC Tier-2 or IPCC Tier-1. Tier-2 estimates require more information regarding production and management of the cattle. However, it is not a perfect tool as there are still uncertainties. Examples of those uncertainties include acclimation of the animals to cold during the winter season (potentially leading to a decrease of enteric methane emissions), and the regional differences in production within a country as immense as Canada.

3 Genetics

1 A second generation radiation hybrid map to aid the assembly of the bovine genome sequence

BMC-Genomics, November 2006, Volume 7, Number 283.

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Several bovine genome maps based on genetic linkage between markers have been published during the last decade. However, linkage maps can only include polymorphic loci and this represents a disadvantage compared to radiation hybrid maps as the latter can be built with sequence information from nonpolymorphic loci. In other words, radiation hybrid maps have the potential to contain more genome information than linkage maps. The authors report that combining information from different sources to produce integrated maps would help to improve the accuracy of genome maps. On the publicly available and current 6x bovine chromosome map, 2898 loci were located without ambiguity in the bovine sequence but, in the BovGen RH map, 131 of those 2898 loci were mapped to different chromosomes. Researchers presented a radiation hybrid map of 30 bovine chromosomes. It was produced with the aid of the Roslin 3000-rad RH panel containing 3966 markers including 2473 new loci. The map also contained 262 amplified fragment-length polymorphisms and 1231 markers of the first generation radiation hybrid map. Identification of inconsistencies was done by comparing mapped loci with those in published genome maps. Researchers observed differences in the order of loci and in the chromosomal assignment of loci. This study concluded that, compared to the current 6x sequence assembly, there was a higher correlation of marker order and chromosome assignment between the BovGen RH map and other published radiation hybrid and genetic maps.

2 Selection for milk production and persistency using eigenvectors of the random regression coefficient matrix

Journal of Dairy Science, December 2006, Volume 89, Number 12, pages 4866-4873.

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There were 4 objectives to this study: 1) to show the development of various eigenvector indexes for increasing milk production and persistency, 2) to define the genetic response to each eigenvector during lactation, 3) to assess the selection potential of eigenvector indexes compared to traditional selection based on lactation estimated breeding value, 4) to assess the number of eigenvectors responsible for the most important part of the variation in the breeding goal. Researchers developed eigenvector indexes based on the K matrix estimated from Japanese Holstein cows. The first eigenvector index relates to the scaling of the lactation curve and it does not change its shape. There was a linear increase of daily genetic responses to the second eigenvector index as days in milk increases. The third eigenvector index generated negative genetic responses in mid-lactation but positive responses during early and late lactation, in the shape of a concave curve. The fourth and fifth eigenvector indexes stayed around zero across the complete lactation period. Therefore, there seems to be little use of the fourth and fifth eigenvectors in improvement of milk production and persistency. However, the second and third eigenvectors have an important impact on the change of the shape of the lactation curve. For increasing milk production only, it was observed that the index from the first eigenvector resulted in a response similar to the index from all 5 eigenvectors. For increasing both milk production and persistency, the index from the first 3 eigenvectors represented more than 99.9 % of the genetic response based on the 5 eigenvectors. The study concluded that the eigenvector index is more effective than conventional selection based on milk production when persistency is given an increased economic value.

3 Analysis of milk urea nitrogen and lactose and their effect on longevity in Canadian Dairy cattle

Journal of Dairy Science, December 2006, Volume 89, Number 12, pages 4886-4894.

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Researchers analyzed data from 1,568,952 records of 283,958 Holstein multiparous dairy cows in 4,578 herds, and data from 79,036 records of 26,784 multiparous Ayrshire dairy cows in 384 herds (all the cows calved from 2001 to 2004). For the Ayrshire cows, the overall average percentage of lactose was 4.49% and the overall average milk urea nitrogen concentration was 12.20 milligrams per deciliter. For Holstein cows, those values were 4.58% and 11.11 milligrams per deciliter, respectively. For survival analysis, the data came from 39,536 first-lactation Holstein cows in 1619 herds, and from 2093 Ayrshire cows in 228 herds. The average percentage of lactose and average milk urea nitrogen concentrations were assembled into 5 groups (low, medium-low, medium, medium-high, high) depending on values of mean and standard deviations. The study focused on several parameters such as: effects of stage of lactation, annual change in herd size, season of milk production, age at first calving, type of milk-recording supervision, effects of protein, fat and milk production, herd-year-season of calving, milk urea nitrogen classes, lactose percentage, and sire. This study highlighted a statistically significant link between lactose percentage and milk urea nitrogen concentration during the first lactation with survival in the 2 breeds (Holstein and Ayrshire). In both cattle breeds, there was a similar relationship between the percentage of lactose and survival. A low level of lactose increases the risk of culling, while a high level of lactose percentage decreases the risk of culling.

4 Precision of estimated QTL positions in granddaughter designs using combined haplotype sharing TDT and linkage analysis

Livestock Science, December 2006, Volume 105, Number 1-3, pages 137-143.

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Results from previous studies have demonstrated that both regression model and transmission disequilibrium test model were suitable for fine mapping of quantitative trait loci in livestock. To detect quantitative trait loci, the simple regression model was developed on the basis of linkage and the use of multiple linear regressions with multiple linked markers, while the transmission disequilibrium test method depends on the analysis of linkage disequilibrium. The objectives of this study were the development of the linear haplotype sharing transmission disequilibrium test (LHS-TDT) procedure and to combine this procedure with the simple regression method in order to estimate the precision of quantitative trait loci positions in granddaughter designs. A Monte Carlo simulation was used to assess the precision of quantitative trait loci. Researchers compared three different linear models: the linear haplotype sharing transmission disequilibrium test model, the linear regression model, and the combination of these two models. Using six scenarios of combinations of markers and the most frequent haplotypes, the mean of absolute differences between the true and alleged quantitative trait loci position of each model was established. With the simple regression model, the mean of absolute difference was 4.38 centimorgans. Depending of the scenario and using the LHS-TDT model, the means of absolute differences were lower than with the simple regression model and ranged from 1.86 to 3.82 centimorgans. When both models were used in combination, the means of absolute difference ranged from 2.32 to 4.36 centimorgans. The study concluded that, compared to the simple regression method and to the combined method for precision of estimated quantitative trait loci position in granddaughters designs, the LHS-TDT method provided better results.

5 Methods of predicting milk yield in dairy cows – Predictive capabilities of Wood's lactation curve and artificial neural networks (ANNs)

Computers and electronics in agriculture, December 2006, Volume 54, Number 2, pages 69-83.

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The objective of this study was to evaluate the potential of using artificial neural networks to predict milk production in full and standardized lactations. Researchers used a dataset of 108,931 daily yields from dairy cows. With the actual data on daily milk production and the data obtained from official milk recording test days, some neural networks were developed and an estimation was made of the parameters of Wood's model. Relative approximation errors, coefficients of determination, and root mean square errors were used for the assessment of the quality of each network and regression model. A subset of 28,576 daily yields used in this study was created to evaluate the prognostic parameters of the two models. Daily and milk production forecasts were produced for the cows in that subset, and those predictions were then compared with actual production records and with the production estimated from the SYMLEK database used in Poland. It was found that, compared to the regression model, the neural networks provided better results for daily production and also for test-day data. Also, the neural networks produced forecasts having a higher degree of correlation between predicted and actual data recorded in SYMLEK. The predictions made by the neural networks had a higher degree of accuracy compared to those resulting from Wood's model.

6 Genetic variants of milk proteins and their effects on the yield and quality of cheese

CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources, December 2006, Volume 1, Number 56, 11 pages.

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Previous research has demonstrated the existence of a link between coagulating properties of milk, along with cheese production and composition, and genetic variants of some milk proteins. In the cheese making process, the composition and production of cheese depend significantly on the association of those genetic variants of milk proteins with the levels of casein and fat in the milk. The difference between genetic variants may also be caused by substitution of amino acids in the polypeptide chain, as this effect would lead to a change of the physiochemical characteristics of the protein. Examples of those effects in some cheese varieties are protein/protein interactions, rate of proteolysis of different genetic variants, and differences in heat stability. Most bovine studies have demonstrated that, compared to the A variant of kappa-casein and the A variant of beta-lactoglobulin, the B variant of those proteins improves cheese production and composition because the B variant is associated to higher levels of casein and fat in the milk. The majority of the research conducted on caprine milk has focused on the study of alpha as1-casein loci. Because it is associated to higher levels of synthesis of alpha s1-casein, variant A has been found to be more appropriate for cheese production than variants E or F. Researchers have also found that, for ovines, beta-lactoglobulin A milk provides better results than beta-lactoglobulin B for cheese making. As for the variant D of alpha s1-casein, it is not suitable for cheese production.

7 Association of bovine leukocyte antigen (BoLA) DRB3.2 with immune response, mastitis, and production and type traits in Canadian Holsteins

Journal of Dairy Science, February 2007, Volume 90, Number 2, pages 1029-1038.

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The objective of this study was to analyze the links between the expression of bovine leukocyte antigen (BoLA) DRB3.2 alleles, and immune response, resistance to mastitis and clinical mastitis. Researchers used data from 328 Canadian Holstein dairy cows from a herd located at the University of Guelph (Ontario). A link was found between BoLA DRB3.2 alleles *3 and *11 and lower somatic cell counts. On the contrary, alleles *22 and *23 were correlated with higher somatic cell counts. Allele *8 was linked to a higher level of risk of mastitis but allele *3 was linked to a lower level of clinical mastitis and somatic cell counts, as well as a higher level of antibodies. It is therefore suggested that more research should be conducted on the BoLA DRB3.2 allele *3 as this antigen can represent a potential for resistance to some types of infections in the mammary glands. This was observed because of the association of BoLA DRB3.2 with lower cell-mediated immune response, especially with one of the test antigens used in the study to assess delayed-type hypersensitivity. BoLA DRB3.2 alleles *11 was linked to a decrease of somatic cell counts while BoLA DRB3.2 alleles *23 was linked to an increase of somatic cell counts but both of them were associated with an increase of production traits. Overall, this study supports the use of alleles *3, *23 and *22 as a set of references for more detailed mechanistic experiments.

8 Application of robust procedures for estimation of breeding values in multiple-trait random regression test-day model

Journal of Animal Breeding and Genetics, February 2007, Volume 124, Number 1, pages 3-11.

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The study was conducted to test several robust estimation methods in the Canadian Test-Day Model for production traits. The data were 980,503 test-day records of 63,346 Canadian Jersey cows. Milk, fat, protein and somatic cell score from the first 3 lactations were analyzed simultaneously, and the model included fixed herd test-day effect and regressions within region-age-season of calving. The model also included regressions with random coefficients for permanent environmental and animal genetic effects. Five robust procedures were contrasted with the regular method of Best Linear Unbiased Prediction (BLUP) with regard to distribution and numbers of outliers (abnormally high or abnormally low observations compared to other observations in the data set) and estimated breeding values (EBV) of animals. A larger frequency of outliers was found during early days of lactation (from 5 to 15) compared with the rest of the lactation period. There was little difference between the ranking of animals using robust evaluations compared to the regular method of BLUP. No significant links were found between the occurrence of outliers and changes in EBV of top animals from different methods. Overall, it was possible to decrease the impact of outlier observations and improve the performance of the model by using computationally simple robust methods.

9 A total merit selection index for Ontario organic dairy farmers

Journal of Dairy Science, March 2007, Volume 90, Number 3, pages 1584-1593.

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The objective of this study was to establish the priorities of selection for organic dairy farming in Ontario and to build a total merit index based on the subjective priorities expressed by the farmers. Organic dairy farming represents an alternative practice that requires a modification in management because health, fertility and fitness are more important than in traditional farming. Indeed, organic farming prohibits the use of chemical fertilizers, pesticides and antibiotics. This is why there is a need to develop new selection objectives adapted to organic dairy farming. Researchers conducted a survey of 18 organic dairy farms in Ontario. This number represents 40 % of all organic dairy farms in that province. Data was collected about their production systems, breeding practices and their concerns about organic dairy farming. It was found that, compared to traditional dairy farms, organic dairy farms produced smaller quantities of milk, they also had higher somatic cell count, lower replacement rate, and a rate of crossbreeding that was significantly higher. Fertility, mastitis, feet and legs production and old age resulted in a culling rate of 21 %. Grazing traits, fertility, health and longevity were the main points of concern for organic dairy farmers. The development of an organic total merit index was therefore undertaken on the basis of subjective scores for traits genetically evaluated in Canada. Because of the small population size of cows in Canadian organic dairy farms, a distinct breeding program would not be viable in the short term.

10 Non-additive genetic effects for fertility traits in Canadian Holstein cattle

Genetics Selection Evolution, March-April 2007, Volume 39, Number 2, pages 181-193.

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Researchers estimated the genetic impacts of additive, additive by additive, dominance, additive by dominance, and dominance by dominance on non-return rates, age at first service, and interval from calving to first service. A discussion was made of practical aspects of computing dominance and additive relationships using the genomic relationship matrix. The final strategy developed was to use several groups of 1000 animals (cows and heifers) with all animals in each of those groups having a non-zero dominance relationship with at least one other animal from within the same group. It was possible to have a direct inversion of relationship matrices in those groups of 1000 animals. Both Bayesian methodology and Gibbs sampling were used to estimate the variances. In general, the estimates of non-additive genetic variances were as large or larger than the additive genetic variance. The only exceptions were non-return rates and interval from calving to first service for cows. In populations representing more than 200000 animals, computing dominance and additive relationships while taking into account all possible pairs of individuals is a very time consuming process.

11 Short communication: Modification of genetic evaluation of herd life from a three-trait to a five-trait model in Canadian dairy cattle

Journal of Dairy Science, April 2007, Volume 90, Number 4, pages 2025-2028.

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The objective of this project was to modify the national genetic evaluation of herd life for Canadian dairy animals from a 3-trait to a 5-trait model. The genetic evaluations for direct herd life were established using elements such as cows' survival from first calving to 120 days in milk, survival from 120 to 240 days in milk, survival from 240 days in milk to second calving, survival to third calving, and survival to fourth calving. Those informations were analyzed with the aid of a multiple-trait animal model. An overall sire evaluation for direct herd life was computed from the combination of sire evaluations from each of the 5 survival traits. To assess sire for indirect herd life, researchers used an index of parameters such as dairy strength, overall mammary, rump angle, feet and legs, milking speed, somatic cell score, interval from calving to first service, and non-return rate in cows. In order to combine direct and indirect genetic evaluations for herd life, researchers used a multiple-trait sire model developed from a multiple-trait across-country evaluation method and this resulted in an overall genetic evaluation for herd life. As for sire assessments for herd life, they were developed as an estimation of transmitted abilities for the quantity of lactations. Finally, the transmitted abilities are represented by the anticipated differences among daughters for herd life when the average herd life is valued at 3 lactations.

12 Construction of bovine whole-genome radiation hybrid and linkage maps using high-throughput genotyping

Animal Genetics, April 2007, Volume 38, Number 2, pages 120-125.

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In order to build a radiation hybrid map for the study of single chromosomes and whole genome, it is necessary to score the presence or absence of markers in a hybrid cell panel made of irradiated donor cells combined with recipient cells of the laboratory rodent. This study focused on the Roslin-Cambridge 3000 rad bovine-hamster whole-genome radiation hybrid panel ($WGRH_{3000}$). Researchers used an Illumina® BeadStation 500G to type large numbers of markers simultaneously. They were able to type successfully 6738 sequence tagged site (STS) markers on the $WGRH_{3000}$ and that, in five multiplex reactions. Usually, when using conventional methods, genotyping the markers on the radiation hybrid panel is the most expensive and time consuming part in the construction of high-density radiation hybrid maps. With this method, researchers have been able to create a high-density whole-genome radiation hybrid map containing 4690 loci and also, a linkage map containing 2071 loci. A confirmation of the typing accuracy was obtained by putting the markers in radiation hybrid maps with 1125 markers that were conventionally typed on the radiation hybrid panel. These two maps provide direct comparison to the bovine whole-genome sequence assembly. The advantage of this method is that, compared to conventional typing and genotyping methods, it was possible to build the maps of this study in significantly less time and for significant less cost.

13 Genetic analysis of milk urea nitrogen and lactose and their relationship with other production traits in Canadian Holstein cattle

Journal of Dairy Science, May 2007, Volume 90, Number 5, pages 2468-2479.

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The objective of this study was to assess lactose and milk urea nitrogen heritability in the first 3 parities and the genetic links of that heritability with milk, protein, fat and somatic cell counts in Canadian Holstein dairy cows. Researchers used a random data sample consisting of 60,645 test-day records from 5,022 dairy cows in 91 herds. That random sample came from a larger data set of 892,039 test-day records form 144,622 Canadian cows in 4,570 herds. It was found that average daily heritability was fairly high for milk urea nitrogen (0.384 to 0.414), lactose percentage (0.478 to 0.508) and for lactose kilograms (0.466 to 0.539). A higher correlation was found between lactose and milk productions (0.979) but no correlations were found between milk production and lactose percentage or milk urea nitrogen. There was a significant link between somatic cell score and lactose (-0.202). Also, fat and protein percentages were correlated with milk urea nitrogen (0.425 and 0.20 respectively). High genetic correlations among parities were observed for lactose percentage, lactose production, and milk urea nitrogen. Because correlations between milk urea nitrogen and lactose percentage with fertility traits were measured at near zero, the potential of using these characteristics as indicators of fertility is reduced.

14 Genetic evaluation of reproductive performance in Canadian dairy cattle

Italian Journal of Animal Science, May-June 2007, Volume 6, Supplement 1, pages 29-37.

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There as been a significant improvement in the productivity of dairy cattle during the past 20 years. It is estimated that between 60 and 80 % of the increase in milk production per lactation is the result of genetic improvements in the herds. Those improvements have also resulted in animals having a better overall conformation. The purpose of this study was to develop a new genetic evaluation system to assess the reproductive performance of dairy cattle in Canada. The system comprises all the 16 traits observed to be linked to reproductive performance: age at first service (heifers), interval from calving to first service (cows), and 7 other parameters applicable to both heifers and cows (gestation length, 56-days non return rate, interval from first service to conception, number of services to conception, direct and maternal calf size, direct and maternal calving ease, and direct and maternal calf survival). The author reports the model previously developed at University of Guelph that takes into account different fixed effects for each evaluated trait. The system provides 2 indices: the first represents daughter fertility and the second, calving performance. An evaluation of the impact of adding those 2 indices in the Canadian Selection Index was also conducted. The author concludes that, to counterbalance a negative impact on fertility traits, there is a need to modify the Canadian Selection Index by giving more weight on daughter fertility (and possibly to include calving performance).

15 Fit of different functions to the individual deviations in random regression test day models for milk production in dairy cattle

Italian Journal of Animal Science, May-June 2007, Volume 6, Supplement 1, pages 153-155.

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In several countries, random regression modelling is used more and more for genetic assessments of dairy cows. This particular model comprises 3 parts: 1) the impacts affecting all cows on the same test day, 2) the effects specific to a particular cow on the test day (for example: pregnancy, disease, etc) and, finally, 3) a number representing the general shape of the lactation curve. Items 1 and 2 are the «fixed part» of the model. Random regression coefficients are used to position individual deviations in relation to the fixed part. The objective of this study was to assess the ability of five of the most used functions of random regression models to position individual deviations around the mean curve. Researchers used data from 53,217 test-day records for milk production representing 6,229 first lactations of Canadian Holstein dairy cows in Ontario. The data were fitted in a model that contained those fixed effects: herd-test date, and days in milk interval in relation to season of calving and age. The results confirm the high level of shape variability between cows when individual lactations are used in the model. This makes it difficult to position those shapes around the mean curve.

16 A molecular analysis of the population of mRNA in bovine spermatozoa

Reproduction: The Official Journal of the Society for Study of Fertility, June 2007, Volume 133, Number 6, pages 1073-1086.

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The process by which haploid spermatids are transformed into spermatozoa is called spermiogenesis. When spermatids are transformed to spermatozoa, a modification is induced in the chromatin structure resulting in a higher level of DNA condensation. The objective of that research was to establish the characteristics of the bovine spermatic ribonucleic acid pool using 2 different methods: 1) by evaluating the integrity of the ribonucleic acid and, 2) by comparing the transcripts found in the bovine spermatids and spermatozoa. The reason for this was to try to find out if messenger RNAs (transcripts) found in the sperm may have a specific function. First, the study of messenger ribonucleic acids integrity was conducted using three technologies: microelectrophoresis (study of the movement of microparticles in a liquid), comparative smearing after global amplification, and polymerase chain reaction (PCR) amplification of target sequences. Second, the technology of microarray hybridizations was used to conduct the transcripts survey. In the first part of the study (integrity of ribonucleic acid in the spermatozoa), researchers found a majority of low molecular fragments, suggesting a natural segmentation process of the messenger ribonucleic acid. With the 2nd evaluation method (survey of the messenger ribonucleic acid), researchers observed that the sperm transcriptome contains a complex mixture of messengers affecting a large amount of cell functions. These messengers represent a large portion of transcripts present in spermatids. The study concluded that since the spermatic RNA population is representative of previous events of the sperm formation, it has potential in being indicative of male gamete quality.

17 Improvement of lactation milk and persistency using the eigenvectors of the genetic covariance matrix between lactation stages

Livestock Science, June 2007, Volume 110, Number 1-2, pages 64-72.

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There were 2 objectives to this research: 1) to develop the restricted and unrestricted indexes using the eigenvectors of the genetic covariance matrix of the stage estimated breeding values, and 2) to evaluate the performance of those two indexes (restricted and unrestricted) for genetic improvement of milk production and persistency. Researchers divided the first lactation of the Japanese Holstein cows into 10 stages. With the eigenvectors of the genetic covariance matrix, various indexes, restricted and unrestricted, were developed. Researchers used those indexes to increase milk production and lactation persistency (difference between the quantity of milk produced at the 280th and at the 55th days in milk). In the unrestricted index, the first 3 eigenvectors accounted for 99.9 % of the performance of the index as compared to the first 5 eigenvectors. Compared to conventional selection based on lactation estimated breeding value, the unrestricted eigen index provides more advantages when persistency receives higher economic weight. The restricted index is more practical than the unrestricted index because there is no need to assign economic values to persistency and lactation milk. The study concluded that the developed eigen indexes provide useful information and easy understanding of the selection practice.

18 Identification of single nucleotide polymorphisms in the bovine CCL2, IL8, CCR2 and IL8RA genes and their association with health and production in Canadian Holsteins

Animal Genetics, June 2007, Volume 38, Number 3, pages 198-202.

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The most widely accepted method of managing mastitis is to record somatic cell scores. The reason for this is the scientifically proven genetic link between high somatic cell scores and clinical mastitis. The first objective of this research was to assess the presence of single nucleotide polymorphisms (SNPs) in bovine chemokine genes CCL2 and IL8, and in chemokine receptor genes CCR2 and IL8RA. The second objective was to study the possible association between those SNPs and five specific parameters : estimated breeding values for somatic cell scores (related to leucocyte trafficking), milk production, fat production, protein production, and udder depth (related to mastitis). Researchers identified 11 single nucleotide polymorphisms using pools of DNA from bulls having high and low estimated breeding value for somatic cell scores. Two new single nucleotide polymorphisms were discovered in the CCL2 gene and another one in the CCR2 gene. An observation was also made of eight single nucleotide polymorphisms identified in previous experiments (five in the IL8RA chemokine receptor and three in the IL8 gene). Using tetra primer ARMS-PCR, seven polymorphisms (three in IL8, one in IL8RA, two in CCL2, one in CCR2) were genotyped in 338 Canadian Holstein bulls. Associations between those seven polymorphisms and 3 production traits (milk production, fat production, protein production) and one trait related to conformation (udder depth) were analyzed.

19 A high resolution radiation hybrid map of bovine chromosome 14 identifies scaffold rearrangement in the latest bovine assembly

BMC Genomics, July 2007, 8:254.

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Compared to other mapping techniques, radiation maps have important advantages because there is no need to use polymorphic markers and, as a result, the potential of mapping larger quantities of loci in increased. In this project, researchers used 843 single nucleotide polymorphisms markers to build a radiation hybrid map of bovine chromosome 14. The map was then compared to the latest version of the Bos taurus bovine genome (Btau_3.1) and also to other radiation hybrid maps previously published. Discrepancies were found between this map and the bovine genome in specific regions of the bovine chromosome 14. In particular, the area near the centromere involving the scaffolds was very different in the map compared to Btau_3.1. The map confirmed the presence of conserved synteny blocks with human chromosome 8. Also, because of the high resolution of the map, it was possible to identify an extra breakpoint and conserved synteny block. This block is located in a region where the correlation is very good between this map and the genome Btau_3.1. The authors concluded that the high resolution radiation hybrid map of bovine chromosome 14 presented in this article is a useful tool to target the regions where more information is needed in order to establish the order of markers.

20 Consistency of maturity rate for milk yield across countries and generations

Journal of Dairy Science, August 2007, Volume 90, Number 8, pages 3937-3944.

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As of November 2006, Canada and 13 European countries were providing data about Holstein bull evaluations (including genetic effects by parity) to assess differences in maturity rate to the International Bull Evaluation Service. The objective of this project was to establish if there is consistency across different counties (Canada, United States, The Netherlands) regarding the differences found in bulls concerning the maturity rate of their daughters. Another objective was to establish if the differences are genetic (transmitted from generation to generation). To calculate 3 evaluations for bulls on the basis of daughter records from parity 1, parities 1 and 2, and parities 1, 2 and 3, researchers used milk record statistics from US Holstein dairy cows with first-parity calving dates positioned between the years 1960 and 1998. The official November 2004 (Canadian) and August 2005 (Dutch) parity-specific evaluations were used to compare the maturity rate of Holstein bull daughters from The Netherlands and Canada with the maturity rate of Holstein bulls from the United States. Differences observed in the maturity rate of bull daughters were the same across countries and were genetically transmitted to the sons' daughters. The study concluded that accounting for maturity differences should result in an increase in accuracy of US evaluations and decrease fluctuation between evaluations. This is especially true for bulls with daughters whose maturity rate for milk production deviate considerably from the population mean.

21 Accounting for heterogeneity of variances to improve the precision of QTL mapping in dairy cattle

Animal Science Journal, August 2007, Volume 78, Number 4, pages 371-377.

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The study of quantitative trait loci mapping of dairy cows usually assumes the homogeneity in daughter or granddaughter designs of multiple sire families. However, there is a possibility that genetic variance is different between different sire families because sons or daughters originate from different dam and different sires groups. The objective of this project was to compare the homogeneous and heterogeneous maximum methods for the mapping of quantitative trait loci in production traits with a granddaughter design. The researchers evaluated data of 433 sons from 6 sire families having 69 microsatellite markers located on 12 chromosomes. They found that, in general, compared to the homogeneous method, the heterogeneous technique resulted in a smaller residual variance and because of that, provided a better fit to the data. In other words, the heterogeneous method produced superior precision for estimation of both positions and effects of quantitative trait loci. Accounting for the heterogeneity of residual variance led to different statistical inferences from ignoring the heterogeneity of variance in mapping quantitative trait loci. The study concluded that the heterogeneous method is useful for quantitative trait loci mapping when the mapping is based on the joint data of various reference populations or heteroscedastic data resulting from crossing animals with different genetic backgrounds.

22 High resolution radiation hybrid map of bovine chromosomes 19 and 29: Comparison with the bovine genome sequence assembly

BMC Genomics, September 2007, Volume 8, Number 310.

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The objective of this research was to produce high-resolution radiation hybrid maps of bovine chromosomes 19 and 29 and compare those chromosomes with the current 7.1X bovine genome sequence. The reason to select chromosomes 19 and 29 instead of the others was the availability from previous research of many quantitative trait loci for carcass merit and residual feed intake on these 2 specific chromosomes. Using a 12,000 rad whole genome radiation hybrid panel, researchers built the maps comprising Single Nucleotide Polymorphism markers: 555 for chromosome 19 and 253 for chromosome 29. After comparing those 2 maps with the current bovine sequence, differences were found in the order of markers for both chromosomes 19 and 29. For both chromosomes, researchers found an important internal change of the markers involving inversion, displacement and flips within the scaffolds. Some of those scaffolds were misplaced in the genome sequence. Comparative maps of cattle-human chromosomes 19 and 29 were also built and, overall, they supported the information displayed in previously published comparative maps even if there were a few differences in the orientation of some homologous synteny blocks. The study concluded that it is possible to improve significantly the current bovine genome sequence by adding information from these 2 radiation hybrid maps. Also, the maps can be used for fine mapping quantitative trait loci and for identify mutations caused by quantitative trait loci for important traits.

4 Health

1 Deferoxamine reduces tissue damage during endotoxin-induced mastitis in dairy cows

Journal of Dairy Science, October 2006, Volume 89, Number 10, pages 3846-3857.

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Intramammary infection is the most common cause of mastitis. The inflammation results in a massive migration of polymorphonuclear neutrophils (naturally present in the blood) into the mammary gland so that they can attack and destroy invading bacteria. Although polymorphonuclear neutrophils are essential for their bactericidal effects, they also produce less desirable effects. Because they release strong oxidants and proteases in their fight against bacteria, polymorphonuclear neutrophils may damage mammary tissue. The objective of this project was to use an endotoxin-induced model to assess the protective effects of 3 antioxidants (catechin, deferoxamine, glutathione ethyl ester), provided in the form of intramammary infusion, on epithelial mammary damages made by polymorphonuclear neutrophils. Researchers used 15 healthy, midlactation dairy cows having no history of mastitis and gave them randomly one of the following treatments: catechin, deferoxamine, or glutathione ethyl ester. Infusions of catechin and glutathione were not effective in protecting against neutrophil-induced damage. However, the infusion of deferoxamine resulted in a decrease of milk lactate dehydrogenase activity, a decrease of NA-Gase activity, and lower level of haptoglobin in milk. The only parameter not affected by deferoxamine as the proteolytic activity of mastitic milk. Overall, those results are indications of the protective effect of deferoxamine. The study concluded that mammary tissue might be protected from neutrophil-induced oxidative stress during mastitis by providing a local infusion of deferoxamine.

2 Seroprevalance of *Mycobacterium avium* subspecies *paratuberculosis*, *Neospora caninum*, bovine leukemia virus, and bovine viral diarrhea virus infection among dairy cattle and herds in Alberta and agroecological risk factors associated with seropositivity

Canadian Veterinary Journal, October 2006, Volume 47, Number 10, pages 981-991.

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The objective of this project was to conduct a study of seroprevalence and agroecological risk factors for *Mycobacterium avium* subspecies *paratuberculosis* (MAP), *Neospora caninum* (NC), bovine leukemia virus (BLV), bovine viral diarrhea virus genotypes 1 (BVDv1) and genotypes 2 (BVDv2) infections of dairy cows in the province of Alberta. Researchers established the seroprevalence of MAP, NC and BLV at 9.1 %, 18.5 % and 26.9 % respectively for adult dairy cattle. At the herd level, seroprevalence was 58.8 % for MAP on the basis of a herd-level test cutpoint of at least 2 seropositive cows. That proportion was 98.7 % for NC, and 86.7 % for BLV, calculated using a herd-test cutpoint of 1 seropositive cow. The seroprevalence of BVDv1 and BVDv2 was 28.4 % and 8.9 % respectively, determined only in herds where the dairy heifers were not vaccinated. The level of herd infection for those 2 diseases was 53.4 % (BVDv1) and 19.7 % (BVDv2). There was a moderate variation of MAP seroprevalence according to agroecological region (especially for the following parameters: aridity and soil pH). The seroprevalence for NC, BLV, BVDv1 and BVDv2 were not affected by the agroecological region. The authors expect to have the data from this project integrated in national Production Limiting Diseases Committee research and control campaigns, and see their data used for directing future research and control programs in the province of Alberta.

3 Monensin might protect Ontario, Canada dairy cows from *paratuberculosis* milk – ELISA positivity

Preventive Veterinary Medicine, October 2006, Volume 76, Number 3-4 , pages 237-248.

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The objective of this study was to assess the effect of monensin sodium in preventing cows from milk-ELISA positive results for *paraturberculosis* in dairy herds of the province of Ontario, Canada. Researchers worked with 4933 dairy cows from 94 herds, among which 44 herds were purposely selected by veterinarians and the rest (50 herds) were randomly selected from. During the period ranging from May through August of 2003, a survey was conducted on each farm to gather information about herd management practices. At the same time and period, milk samples from all lactating cows were also collected by researchers and then, tested with a milk-ELISA (Enzyme Linked ImmunoSorbent Assay) to assess the presence of antibodies to *Mycobacterium avium* subspecies *paratuberculosis*. There were 46 herds (out of the total 94) having a prior history of *paratuberculosis*. For those particular herds, giving monensin to the breeding-age heifers resulted in a decrease of the odds of a cow testing positive (odds ratio = 0.54). For the other 48 herds in which the disease had never been diagnosed, using monensin (odds ratio = 0.21) and calf hutches (odds ratio = 0.19) in milking cows resulted in a decrease of the odds of a cow testing positive. The study concluded that, although the use of monensin may be correlated with positive results for milk-ELISA, more research will be needed to understand the influence of this compound on the transmission of *paratuberculosis*.

4 Johne's disease in Canada Part II: Disease impacts, risk factors, and control programs for dairy producers

Canadian Veterinary Journal, November 2006, Volume 47, Number 11, pages 1089-1099.

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Johne's disease is an inflammation of the digestive tract of ruminants. It is caused by a bacteria (*Mycobacterium avium* subspecies paratuberculosis) and results in severe diarrhea affecting negatively the animals. In a previous research (Johne's disease in Canada Part I), researchers characterized the main parameters of Johne's disease: diagnosis, pathobiology, clinical stages, and epidemiology. This study is a continuation of Part I and provides an overview of the economic consequences of the disease. It also provides information on the risk factors associated with the disease and reviews the control programs currently in force within the United States, the Netherlands, and Australia. The milk production of cattle tested positive to the bacteria decreases by at least 370 kilograms over the 305-day lactational period. Because of premature culling and reduced slaughter value, the losses are estimated to be of $ 1330 Canadian dollars per year per infected 50-cow herd. As of today, research has been unable to find a consistent link between the bacteria and reduced fertility, or the risk of mastitis. Among animal-related risk factors are age, level of exposure, and source of exposure (milk, colostrum, manure, etc.). Agent factors include the level of infection and the genetic variant of bacteria. The study concluded that control of Johne's disease can be accomplished by implementing biosecurity measures and with the aid of strategic testing and culling.

5 Test characteristics from latent-class models of the California Mastitis Test

Preventive Veterinary Medicine, November 2006, Volume 77, Number 1-2, pages 96-108.

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The California Mastitis Test (CMT) was developed in 1957 as an inexpensive and easy diagnosis tool for rapid and reliable detection of abnormalities (somatic cell count or total leukocyte) in milk. Many attempts have been made during the past 50 years to use the CMT as a predictor of intramammary infection. However, all studies have concluded that the CMT would need more sensitivity in order to be used in the screening of animals for intramammary infection. The main objective of this study was to assess the sensitivity and specificity of the California Mastitis Test for detecting the presence of intramammary infection on the day of dry-off, using latent-class methods and culture as the second test. Researchers used 752 Holstein-Friesian dairy cows from 11 herds and collected milk samples for bacteriological analysis. On the day of dry-off, the California Mastitis Test was conducted on the cow before milking. The sensitivity and specificity of the CMT to detect all possible pathogens were assessed at 70 % and 48 % respectively. The sensitivity performance of the test increased to 86 % when only the most dangerous pathogens were investigated. As for the negative predictive value of the CMT, it was established at over 95 % for herds having a prevalence of major pathogen intramammary infection lower than 15 %.

6 *Clostridium difficile* PCR ribotypes in calves, Canada

Emerging Infectious Diseases, November 2006, Volume 12, Number 11, pages 1730-1736.

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Clostridium difficile is a bacterium associated with colitis and diarrhea in humans. There were three objectives to this study: 1) to assess the role of *Clostridium difficile* in neonatal calf diarrhea, 2) to characterize *C. Difficile* isolates from calves (both genotypically and phenotypically) and 3) to compare human and calf isolates. Researchers worked with calves from 102 dairy farms across Southern Ontario. Fecal samples were obtained from 144 calves with diarrhea and 134 from non-diarrheic calves for a total of 278 animals. Samples were evaluated for *Clostridium difficile* toxins (A and B) using an ELISA (Enzyme immunoassay). *Clostridium difficile* was found in 31 of the 278 calves. It was present in 11 of the 144 (7.6 %) calves with diarrhea, and in 20 of the 134 (14.9 %) calves without diarrhea. Analyses at the farm level revealed the presence of *Clostridium difficile* toxins in 58 of the 102 (56.8 %) farms tested. In calves, *C. Difficile* toxins were detected in 57 of 144 (39.6 %) calves with diarrhea, and in 20 of 134 (20.9 %) calves from the control group. Molecular analysis-PCR-ribotyping of 31 *C. difficile* isolates, revealed the presence of 8 different genetic types. Two of those 8 types, PCR-Ribotypes 017 and 027 have been linked to severe outbreaks of *Clostridium difficile*-associated disease in people worldwide. The study concluded there is a possible link between calf diarrhea and *Clostridium difficile.*

7 Field study of the efficacy of halofuginone and decoquinate in the treatment of *Cryptosporidiosis*

Veterinary Record: Journal of the British Veterinary Association,
November 2006, Volume 159, Number 20, pages 672-676.

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Cryptosporidiosis is an intestinal disease caused by a protozoa and results in diarrhea and weight loss in young calves. The objective of this project was to compare the efficacy of halofuginone and decoquinate for treatment of *Cryptosporidiosis* in a farm producing veal calves unit. Researchers worked with 90 veal calves (aged from 7 to 10 days old) divided in 3 groups of 30. The first group was the control (no medication), the second group received halofuginone hydrobromide (100 micrograms per kilogram of animal weight) and, calves from the third group received decoquinate orally (2 to 5 milligrams per kilogram of animal weight). The medication was given daily during a period of seven consecutive days. Beginning at the first day of the experiment, a daily monitoring of diarrhea and dehydration was performed during 28 consecutive days. Fecal samples were also collected on the first day of the experiment and every 7 days until day 28 (0, 7, 14, 21 28). Finally, calves were weighed 2 times : on day 3 and on day 28. Researchers observed no effect of the treatments on the levels of dehydratation and diarrhea, and no effects either on the ratios of calves having diarrhea or calves excreting oocysts. Compared to decoquinate, halofuginone had a better performance in reducing the excretion of oocysts on day 7, whereas decoquinate calves had worked better average daily weight gain.

8 Parenteral administration of glutamine modulates acute phase response in postparturient dairy cows

Journal of Dairy Science, December 2006, Volume 89, Number 12, pages 4660-4668.

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Lactation is very demanding on the metabolism of dairy cows, as it requires lots of energy and proteins from the animal. In previous experiments, it was demonstrated that the level of glutamine in the plasma decreases from 25 to 33 % during lactation (glutamine is the most abundant amino acid in milk and blood plasma). The objective of this study was to evaluate the effect of providing a supplement of L-glutamine to lactating cows. Researchers worked with 24 multiparous Holstein dairy cows and divided them in 3 groups of 8 cows according to the expected calving date. The animals were randomly given one of the following: 1) intravenous infusion of 10 liters of sodium chloride (control group), 2) intravenous infusion of 106 grams per day of L-glutamine mixed in 10 liters of sodium chloride, 3) intravenous infusion of 212 grams per day of L-glutamine mixed in 10 liters of sodium chloride. The treatments were given for 8 hours per day for 7 consecutive days starting on the first day after calving. Researchers observed that providing L-glutamine to the lactating cows resulted in 2 different effects: 1) it increased the quantity of serum amyloid A and LPS-bonding proteins and 2) it decreased the quantity of haptoglobin in their plasma. These results indicate L-glutamine has an effect on the production of proteins during acute phase, and on the adequate functioning of the mucosal barrier. The study concluded that more research is needed to understand the process by which L-glutamine increases the quantity of proteins during acute phase.

9 *Giardia duodenalis* and *Cryptosporidium spp.* in a veterinary college bovine teaching herd

Veterinary Parasitology, December 2006, Volume 142, Number 3-4, pages 231-237.

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Giardia duodenalis and *Cryptosporidium* are 2 intestinal parasites commonly found in various domestic and wild animals, and also in humans. Infection is mostly transmitted by ingesting cysts (*Giardia duodenalis*) or oocysts (*Cryptosporidium*) present in the excrements of the infected animal/person. However, one of the main routes for human contamination is infected water. The objective of this study was to assess the prevalence, characteristics and potential of transmission to humans working in a veterinary college, of *Giardia duodenalis* and *Cryptosporidium* from adult cattle herd. Over a period of 8 months, researchers collected a total of 507 fecal samples from 30 different cows. The samples were analyzed in a laboratory for cysts (*Giardia duodenalis*) and oocysts (*Cryptosporidium*). During the 8-month period of the experiment, the proportion of cows infected with *Giardia duodenalis* varied from a low of 37 % (11 cows out of 30) up to 64 % (18 cows out of 30), giving an overall mean of 49 %. The cumulative infection ratio was 22 cows out of 30 (73 %). Zoonotic *Giardia duodenalis* assemblage A genotype was identified in 43% (6/14) of the G. duodenalis-positive samples on which polymerase chain reaction (PCR) and genetic sequencing were successfully performed. *Cryptosporidium* was not detected in any of the cows during the length of the experiment. The study concluded that, for this particular veterinary facility, the risk of humans being infected with *Cryptosporidium* is negligible, whereas the risk of humans being infected by *Giardia duodenalis* is present.

10 Effects of nitric oxide on bovine polymorphonuclear functions

Canadian Journal of Veterinary Research, January 2007, Volume 71, Number 1, pages 52-58.

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Mastitis is a physiological reaction of dairy cows to an intramammary infection. Each year, this frequent disease is the cause of major economic losses for dairy producers. When mastitis occurs in a cow, the body of the animal reacts by transferring massive amounts of polymorphonuclear neutrophils from the blood to the infected mammary gland. Those neutrophils then attack the bacteria by producing toxic oxygen radicals. However, one of those radicals (nitric oxide) can also cause damage to the mammary tissues because it reacts with other molecules to form a strong oxidant. The objective of this research was to assess the effects of 1) nitric oxide and 2) inhibitors of inducible nitric oxide on the performance of bovine polymorphonuclear neutrophils. Researchers conducted 2 experiments, beginning by inducing mastitis in dairy cows. They also infused aminoguanidine as the inhibitor of inducible nitric oxide. Then, a count was made of somatic cells from milk samples. An evaluation was also made of superoxide production induced by phorbol myristate acetate. There was no effect of aminoguanidine or nitric oxide on polymorphonuclear neutrophils, in both experiments. The study concluded that nitric oxide does not have a huge impact on the neutrophils.

11 Comparison of serological methods for the diagnosis of *Neospora caninum* infection in cattle

Veterinary Parasitology, January 2007, Volume 143, Number 2, pages 166-173.

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Neospora caninum is a protozoon that causes abortion in several mammals, including cattle. A diagnosis can be made by testing the animals for Neospora caninum antibodies. The first objective of this research was to assess the efficacy and agreement of 4 commercial and 2 in-house antibody assays for *Neospora caninum* in dairy cows. The second objective was to examine the reproducibility of 2 tests conducted in different laboratories. For this study, a total of 397 samples from 34 herds were used (183 seronegative and 214 seropositive samples for *Neospora caninum*). These samples came from a large pool of serum samples collected in 1998 in 3 Canadian provinces (New Brunswick, Nova Scotia, Prince Edward Island) and stored since then in a freezer at –20 ºC. The antibody tests evaluated in this study represented 3 different technologies: ELISA (Enzyme-Linked ImmunoSorbent Assay), IFAT (Indirect Fluorescent Antibody Test) and NAT (*Neospora caninum* Agglutination Test). There were 3 ELISA tests from different commercial manufacturers, 2 IFATs (one commercial and one from in-house source) and one NAT (from in-house source). The study concluded that the efficacy of most test products evaluated in this experiment was good for screening *Neospora caninum* antibodies in dairy cows.

12 Response of calves to challenge exposure with virulent bovine respiratory syncytial virus following intranasal administration of vaccines formulated for parenteral administration

Journal of the American Veterinary Medical Association,
January 2007, Volume 230, Number 2, pages 233-243.

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The objective of this study was to evaluate the efficacy of commercial vaccines in protecting young calves against bovine respiratory syncytial virus. The vaccines were of two different types: single-fraction and combination modified-live. Both vaccines were to be administered intranasally to the animals. Researchers worked with 39 newly born Holstein calves and fed them with 1.5 liter of bovine colostrum containing a minimal amount of antibodies for bovine respiratory syncytial virus. This was done to make sure the calves were seronegative at the moment of the first vaccination. In the first two experiments, calves aged 9 weeks old were vaccinated with the single-fraction and with the modified-live products against the bovine respiratory syncytial virus. Twenty-one days after vaccination, they were exposed to the virus. In the third experiment, calves aged 2 weeks old received the combination modified-live vaccine. Eight days after vaccination, they were exposed to the virus. A control group of calves received no vaccination. After the experiment, all the animals were euthanized. Autopsy revealed that unvaccinated calves displayed severe respiratory tract disease, pulmonary damage and some calves died from the disease before the end of the experiment. The lungs of the vaccinated calves were in much better condition. The study concluded that the intranasal vaccines were performing in protecting calves against the bovine respiratory syncytial virus.

13 Production effects of pathogens causing bovine leukosis, bovine viral diarrhea, paratuberculosis, and neosporosis

Journal of Dairy Science, February 2007, Volume 90, Number 2, pages 659-669.

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Some infectious diseases can be present in apparently healthy animals. This is the case for infections by *Neospora caninum*, *Mycobacterium avium* subspecies *paratuberculosis (MAP)*, Bovine viral diarrhea virus, and Bovine leukemia virus. Infected farms may suffer from economic losses associated with these diseases. The objective of this study was to assess the impacts of seropositivity for *Neospora caninum*, bovine viral diarrhea virus, *MAP*, and bovine leukemia virus on 3 production parameters of dairy cows: 305-day milk yield, 305-day fat yield, and 305-day protein yield. Researchers worked with 30 cows randomly selected from 342 herds. They collected and tested serum samples on a monthly basis, looking for antibodies against the diseases. No link was found between bovine leukemia virus and any of the 3 production parameters evaluated. Seropositivity to *MAP* resulted in a decrease of 305-day milk production (212 kilograms less) in older cows (lactation 4 plus). Bovine viral diarrhea virus had a negative effect on the 305-day production of milk (368 kilograms less), 305-day fat production (10.2 kilograms less), and 305-day milk protein (9.5 kilograms less). Seropositivity to *Neospora caninum* resulted in a decrease of 305-day milk production (158 kilograms less), 305-day fat production (5.5 kilograms less), and 305-day protein production (3.3 kilograms less) in first lactation animals, but not in older cows. The study concluded that the findings from this research will bring a better understanding of the economic impacts of the diseases.

14 Ruminal lipopolysaccharide concentration and inflammatory response during grain-induced subacute ruminal acidosis in dairy cows

Journal of Dairy Science, February 2007, Volume 90, Number 2, pages 856-866.

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Subacute ruminal acidosis is a common problem in lactating dairy cows. Some previous studies have found a possible link between subacute ruminal acidosis and lipopolysaccharide, an endotoxin found in gram-negative bacteria. The objective of this experiment was to assess the impact of inducing subacute ruminal acidosis on parameters such as free ruminal lipopolysaccharide, level of lipopolysaccharide in blood, serum amyloid A, haptoglobin, fibrinogen, white blood cell profiles, and serum copper. Researchers worked with 4 mid lactation dairy cows, divided in 2 groups of 2. They induced subacute ruminal acidosis in 2 cows by replacing 25 % of their usual total mixed ration with a concentrate pellets made of 50 % barley and 50 % wheat. The 2 other cows were the control group and received the total mixed ration containing 44 % of dry matter of concentrate feed. Inducing subacute ruminal acidosis in the cows had no impact on milk composition. However, it resulted in an increase from 187 to 309 minutes per day of the duration of rumen acidity (pH) below 5.6. It also resulted in an increase of free lipopolysaccharide in rumen fluid of 24,457 to 128,825 endotoxin units per millilitre and in increase of the acute phase protein serum amyloid A in peripheral blood from 286.8 to 498.8 ug/mL. The tests indicated that ruminal acidosis also occurred in cows from the control group but to a lesser extent. The study concluded that the lysis of gram-negative bacteria increases and results in an inflammation of the rumen when subacute ruminal acidosis is induced in mid lactation dairy cows by means of grain diet.

15 Canadian veterinarians' use of analgesics in cattle, pigs, and horses in 2004 and 2005

Canadian Veterinary Journal, February 2007, Volume 48, Number 2, pages 155-164.

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Researchers conducted a national survey and asked 1431 veterinarians (randomly selected) to fill a questionnaire about their use of analgesics for routine surgeries and for treatment of medical problems in cattle, beef, horses, and pigs. The response rate was 50.1 %. Over 90 % of veterinarians reported the use of analgesics for surgeries on horses, for cesarean procedures on sows and cows, and also for omentopexy and claw amputation of bovines. Researchers found that many analgesic use protocols were inadequate and many young animals did not received analgesics following routine procedures. For castration, 95.8 % of horses were provided with analgesics, compared with 33.2 % for dairy calves aged over 6 months, 19.9 % of beef calves aged over 6 months, 18.7 % of dairy calves aged 6 months or less, 6.9 % of beef calves aged 6 months or less, and less than 0.001 % of piglets received analgesics for castration. The majority of veterinarians agreed in saying that long-acting and cost-effective analgesics are not available. They also said that the benefits of using analgesics are often outweighed by long withdrawal periods. The study concluded that veterinarians have an urgent need for support (continuing education, more long-acting and cost-effective drugs) in order to provide better control of pain in animals.

16 Fetal well-being assessment of bovine near-term gestations: Current knowledge and future perspectives arising from comparative medicine

Canadian Veterinary Journal, February 2007, Volume 48, Number 2, pages 178-183.

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The objective of this study was to review methods for evaluating the well-being of bovine fetus and to highlight the elements that could be used to evaluate both viability and health condition of the fetus in the last trimester of cattle pregnancy. The review conducted in this work presents the state of knowledge on well-being of fetus from several studies based on humans, ovines, equines and bovines. It also presents promising characteristics investigated in other species but not yet studied in bovines. Very few information is available about the assessment of health condition of bovine fetus during late pregnancy. An examination with ultrasounds can provide important information for diagnosis of hydrallantois and large placentomes as they are often associated with clone pregnancies. Large hyperechoic pieces or inactivity of the fetus are signs of fetal distress or possible death. Those signs must be evaluated rapidly to confirm the diagnosis. Early detection of large offspring syndrome (often founded in cloned calves) can be made by measuring fetal parameters such as metacarpal or metatarsal thickness, and thoracic aorta. Large offspring syndrome results in increased placentome size, increased fetal size, and increased length of pregnancy. On the contrary, premature calving can occur if the pregnant cow is stressed.

17 Adherence and efficacy of an external teat sealant to prevent new intramammary infections in the dry period

Journal of Dairy Science, March 2007, Volume 90, Number 3, pages 1289-1300.

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During the period of dry-off, dairy cows are at a high risk of developing new intramammary infections. Bacteria enter the cow's udder through the teat canal. Dry cow antibiotic treatments are commonly used as a preventive measure, but their action does not last for very long. Recently, internal sealants have been developed to protect the cows by making an inert barrier against bacteria inside of the udder. There is also another type of sealant that can be applied externally on the cows' teats. The objective of this study was to assess the parameters affecting the efficacy and adherence of a teat sealant applied externally at drying off. The studies were conducted from 1997 to 1999. In this experiment, researchers found significant differences between herds in the duration of sealant adherence on the teat ends. The authors suggest that some management procedures can explain the difference in the duration of sealant adherence. Some factors were found to extend the duration of sealant adherence to the teats: cooler seasons, longer teat lengths, and double sealant application. Double coating the teats with the sealant resulted in beneficial effects. The study concluded that sealing the teats at dry-off reduces the incidence of infection, if the teats are covered with a durable seal that stays in place for enough time.

18 Herd management factors that affect duration and variation of adherence of an external teat sealant

Journal of Dairy Science, March 2007, Volume 90, Number 3, pages 1301-1309.

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External sealing products can be applied to the teat-ends of cows during dry-off to help prevent intramammary infection. The sealant acts as a protective barrier against pathogens trying to enter inside the udder. The objective of this study was to point out herd management procedures that can improve the duration of the external sealant during the dry-off period of commercial dairy cows. Researchers worked with 74 herds from Ontario, providing a commercial external sealant and a questionnaire to each of them. The sealing product was applied to all cows having one or more lactation and scheduled for dry-off. A scale of 1 to 5 was used to report the adherence of the teat sealant (5 = excellent adherence, 1 = sealant completely removed) during the first 12 days after dry-off. It was possible to analyze complete data from 806 cows from 48 herds. The duration of the sealant of the teats ranged from 1 to 7 days (mean of 4 days). Adequate preparation of teat ends prior to the applying the sealant is an important factor of success. It is possible to prolong the adherence of the sealant by modifying the feed ration before drying-off to reduce milk production. None of the evaluated factors related to cow housing, floor surface or bedding material was linked to the duration of the adherence of the sealing product.

19 Defribinated bovine plasma inhibits retroviral transcription by blocking p52 activation of the NF kappa B element in the long terminal repeat

Canadian Journal of Veterinary Research, April 2007, Volume 71, Number 2, pages 119-128

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Bovine leukemia virus (BLV) is the cause of bovine leukosis, which develops in less than 10 % of infected cattle. The majority of cattle have no symptoms of infection, with the virus remaining in a latent (non-replicating) state but one third will develop persistent lymphocytosis, a benign expansion of peripheral blood lymphocytes. Plasma blocking factor (PBF), a natural compound present in human and bovine plasma, is responsible for the latency of the virus. Understanding the mechanism by which Bovine leukemia virus is maintained latent in animals could be useful in controlling other types of retroviral infections. The objective of this research was to identify the means by which PBF stopped viral production. In this study, bovine plasma had no effect in inhibiting the promoters of Bovine immunodeficiency virus, Feline immunodeficiency virus, or Feline leukemia virus, but did inhibit BLV, human immunodeficiency virus (HIV) and human T cell leukemia virus. Virally infected cells stimulated by ionomycin and phorbol esters were shown to produce virus, but viral production was arrested in the presence of PBF. The NF kappa B element was studies further since promoters of BLV, HIV and HTLV shared this element at the transcription start site and the other virsues lacked this site. Upon quantification of the NF kappa B proteins in nuclear extracts (of either mononuclear blood cells or Jurkat cells), researchers observed that all 5 members of the NF kappa B family responded to stimulation by increasing concentration in cell nuclei, whereas in the presence of PBF, only p52 decreased in concentration in cell nuclei. The study concluded that plasma factors restrict viral transcription in cattle either by interference with p52 synthesis or p52 translocation to the nucleus.

20 Effect of repeated arthrocentesis and single joint lavage on cytologic evaluation of synovial fluid in 5 young calves

Canadian Journal of Veterinary Research, April 2007, Volume 71, Number 2, pages 129-134.

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Joint diseases are the 2nd most important cause of lameness in dairy cows. They affect the animals' condition, resulting in decreased milk production. The analysis of synovial fluid is the most used test to establish if the joint disease is infectious or non-infectious. However, because repeated sampling of synovial fluid is sometimes required for diagnosis and evaluation purposes, this can also affect the joint condition. The objective of this project was to assess the impact of a single joint lavage and repeated arthrocentesis on the characteristics of synovial fluid. Researchers worked with 5 Holstein calves, focusing on the left tarsi of the animals. First, they collected synovial fluid each day during 4 days and then, every 4 days until day 24. A joint lavage for all the calves was done on day 2. Cytologic evaluations were made in order to assess total leukocyte count, total protein concentration, and differential count of lymphocytes, monocytes and neutrophils. Negative results were observed for bacterial cultures collected on day 2, and also for signs of joint disease during the length of the study. The study concluded that, even though arthrocentesis induces a moderate inflammation, there is a quick adaptation of the joint. It is recommended to provide a 4-day interval between each arthrocenteses when they are done to study cellular components of the synovial fluid.

21 Efficacy of vaccination in preventing giardiasis in calves

Veterinary Parasitology, May 2007, Volume 146, Number 1-2, pages 182-188.

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Giardia duodenalis is a common infection in ruminants from all over the world. It occurs usually in animals of about one month of age, and results in diarrhea and other signs of infection. The objective of this research was to assess the efficacy of a vaccine for protecting calves against infection by *Giardia duodenalis*. Researchers vaccinated an experimental group of 6 calves, aged 2 weeks old, with a sonicated *Giardia duodenalis* trophozoite vaccine. 6 other calves representing the control group were given a saline solution. After 28 days, all the calves from both groups received another injection. After 11 days following the second injection, the calves were given an oral solution of purified *Giardia duodenalis* cysts from an infected calf. Fecal samples were then collected on a regular basis for laboratory screening. Blood samples were also collected every week until the moment the calves were provided with the *Giardia duodenalis* cysts, and every 2 weeks after that. Fourteen days after they received the cysts, all the calves were euthanized and researchers counted the trophozoites in the small intestine of the animals. Compared to unvaccinated calves, the vaccinated group had a higher level of serum antibody titers and excreted a higher level of *Giardia duodenalis* cyst in their feces. However, the quantity of trophozoites in the small intestine was similar between the 2 groups. The study concluded that the vaccine was not successful in preventing the infection in calves.

22 Use of an enzyme-linked immunosorbent assay in bulk milk to estimate the prevalance of *Neospora caninum* on dairy farms in Prince Edward Island, Canada

Canadian Veterinary Journal, May 2007, Volume 48, Number 5 , pages 493-499.

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There were 3 objectives to this research: 1) to assess the possibility of using bulk milk as a diagnosis tool to estimate Neospora caninum at the herd-level, 2) using bulk milk, to assess the number of dairy farms in Prince Edward Island having 15% or more of their cows revealing seropositivity to *Neospora caninum*, 3) to assess the concentration of *Neospora caninum* antibodies over time in bulk milk. Using an ELISA (Enzyme-Linked ImmunoSorbent Assay), researchers analyzed samples of bulk skimmed milk and individual serum samples, looking for *Neospora caninum* antibodies. A total of 659 milk samples were tested: 235 were collected in May 2004, 180 in May 2005, and the rest (235) in June 2005. Results from the analysis showed that, in May 2004, 6.4% of dairy farms in Prince Edward Island had 15% or more of their cows with seropositivity to *Neospora caninum*. That percentage was 10.1% for May 2005, and 10.2% for June 2005. Blood samples and another bulk milk sample were collected in September 2005 in each of the 11 farms tested positive based on the ELISA evaluation with bulk milk. The analysis of the blood samples and the milk sample resulted in an accordance of 87%. The study concluded that ELISA testing with bulk milk can be used to estimate the level of *Neospora caninum*.

23 Efficacy of a lactoferrin-penicillin combination to treat o-lactam-resistant *staphylococcus aureus* mastitis

Journal of Dairy Science, June 2007, Volume 90, Number 6, pages 2778-2787.

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The objective of this project was to evaluate the efficacy of penicillin G alone or combinations of bovine lactoferrin-penicillin against mastitis caused by *Staphylococcus aureus*. After confirming that penicillin alone can't cure the infection, researchers induced mastitis in experimental animals by injecting a low dose of Staphylococcus in each of the 4 teats of 19 late lactating dairy cows. Following a wait period of 15 days, infected cows were randomly given in each of their quarters one of the following : 1) citrate buffer, 2) 100,000 international units of penicillin G, 3) 1 gram of bovine lactoferrin, 4) 1 gram of bovine lactoferrin and 100,000 international units of penicillin G. The treatments were given twice a day during 5 days. Another similar experiment was also conducted to evaluate the effect of the same treatment on cows infected for a longer time. After screening milk samples for bacterial concentration and somatic cell count, researchers observed a 0 % cure rate for the control quarters (citrate buffer), 11.1 % for bovine lactoferrin alone, 9.1 % for penicillin G alone, and 45.5 % for the combination of bovine lactoferrin and penicillin G. For cows infected for a longer time, the cure rate was 12.5 % for penicillin G alone, and 33.3 % for the combination of bovine lactoferrin and penicillin G. The study concluded that combining bovine lactoferrin with penicillin is an effective method for treating intramammary infections caused by Staphylococcus aureus.

24 The effects of subclinical ketosis in early lactation on reproductive performance of postpartum dairy cows

Journal of Dairy Science, June 2007, Volume 90, Number 6, pages 2788-2796.

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Previous research has reported an association between calculated negative energy balance and reproductive traits, including days to first luteal activity, first service conception risk, days from calving to first AI and days from calving to conception. Circulating ketone body concentration can be used to estimate the energy status of individual cows. Reproductive performace recorded from 796 Holstein cows enrolled in a clinical trial to investigate the health impact of a monensin controlled release capsule were analyzed to investigate the association between circulating serum BHBA concentration in the periparturient period and subsequent reproductive performance. Specifically, this retrospective analysis was designed to investigate relationships between the magnitude and duration of increased serum BHBA measured at -3 wk, and in each of the first, second, third, sixth and ninth week postpartum, and the pregnancy risk at first insemination, the time from calving to first AI, and time from calving to pregnancy. Over the entire study period cows diagnosed not pregnant after first AI experienced increased circulating BHBA concentrations throughout the observed time period relative to pregnant cows. In the first week after calving cows with circulating BHBA concentrations ³1000 μmol/L were less likely to be diagnosed pregnant after first insemination. In the second week postpartum the cows with ciculating BHBA concentrations ³1400 μmol/L were significantly less likely to be pregnant after first AI. A dose response relationship was found when a comparison of the probability of pregnancy after first insemination and duration of elevated circulating ketone bodies was investigated. The probability of pregnancy was reduced by 20% in cows diagnosed as subclinically ketotic in either the first or second week. Furthermore, cows above the subclinical ketosis threshold in both the first and second week postpartum were 50% less likely to be pregnant after first insemination. Similarly, the median time to pregnancy was increased in cows experiencing elevated BHBA concentrations in either (124 d) or both (130 d) the first and second week postpartum relative to cows never experiencing elevated BHBA concentrations (108 d).

25 Cell-mediated immune responses induced by BHV-1: rational vaccine design

Expert Review of Vaccines, June 2007, Volume 6, Number 3, pages 369-380.

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Bovine herpesvirus-1 (BHV-1) is a pathogen affecting the respiratory functions of cattle all over the world. It is also the cause of infections to the genital tract, and of several other health problems such as conjunctivis, central nervous system deficiencies and even abortions in the case of pregnant cows. Antibodies can protect the animals from BHV-1, they can also make the cattle recover from that infection. However, another critical point of defense is the cell-mediated immune response, as cell-to-cell transmission of the virus is the first level of event following an infection. It is also important to have a strong T-cell memory in order to get long lasting protection. The effects of attenuated conventional vaccines are long-term memory and balanced immune response. Their downside is the possibility of viral shedding. As for inactivated vaccines, their main characteristics are short-term memory and humoral immune response. Current commercial vaccines do not have the ability to distinguish between healthy and infected cows. Recent research and development projects have targeted the development of a vaccine that will not only have differentiation markers, but also provide both long-term memory and balanced immune responses. Promising candidates include well-defined, genetically engineered gene-deleted, subunit and vectored vaccines.

26 Milk and serum J5-specific antibody responses, milk production change, and clinical effects following intramammary *Escherichia coli* challenge for J5 vaccinate and control cows

Clinical and Vaccine Immunology, June 2007, Volume 14, Number 6, pages 693-699.

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Bacterium *Escherichia coli* is a frequent cause of bovine coliform mastitis. This disease can result in abnormal milk, loss of milk production, veterinary costs, and even death of the cows. J5 vaccines have been used for over 15 years in the dairy industry to protect cattle against *Escherichia coli*, but several of the functioning mechanisms of the vaccine are not all well understood. The objectives of this experiment were 1) to assess the performance of a commercial J5 vaccine against *Escherichia coli* and 2) to test for correlations between the J5 vaccine, severity of clinical mastitis, and the level of J5-specific antibodies in milk before and after the induction of bacteria. Researchers worked with 8 Holstein dairy cows, providing vaccine to 4 of them and using the 4 others as the control group. The cows were selected based on low somatic cell count and no record of intramammary infection. *Escherichia coli* was induced in all the cows when they were between 8 to 16 days in milk. Overall, J5 vaccinated cows responded better than unvaccinated cows against the bacteria. The study concluded that, following the induction of bacteria in the cows, J5 vaccination resulted in higher count of J5-specific immunoglobulin IgG1 and IgG2 during early lactation, faster disappearance of *Escherichia coli* in milk, a decrease of somatic cell count, and a lower loss of milk.

27 Somatic cell count during and between milkings

Journal of Dairy Science, August 2007, Volume 90, Number 8, pages 3733-3741.

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Subclinical mastitis in dairy cows is mostly diagnosed using measurement of the somatic cell count, because bacterial infection of the mammary gland is the most important factor resulting in an increase of somatic cells. Other nonbacterial factors may also affect the quantity of somatic cells in milk: season, stress, age, stage of lactation, day-to-day variation, management, and variation during daytime. There were 2 objectives for this study: to evaluate the impact of sampling time on specificity and sensitivity of somatic cell count when this method is used to diagnose intramammary infection, and to find out which cells induce the variation of somatic cell count during daytime. Researchers worked with 6 herds from Prince Edward Island dairy farms. Milk samples were collected immediately before, halfway and immediately after the morning milking, then every hour after the morning milking, and immediately before the afternoon milking. The authors observed that the somatic cell count was significantly lower immediately before the afternoon milking compared to immediately before the morning milking. Using a cutoff point of either 200,000 or 500,000 cells per milliliter, the specificity of somatic cell count as a symptom of intramammary infection was much lower following the morning milking. Compared with the somatic cell count in samples in the forestrippings of the morning milking, somatic cell count of quarters with no infection was higher between milkings up to 7 hours after milking. The research also revealed the presence of a larger quantity of polymorphonuclear leukocytes immediately after milking in quarters having a high somatic cell count. The study concluded that, in order to get accurate measures of somatic cell count, milk samples should always be taken immediately before milking the cows. Samples collected up to 7 hours after milking do not accurately reflect the somatic cell count of that quarter.

28 D-lactic acid-induced neurotoxicity in a calf model

American Journal of Physiology, Endocrinology and Metabolism,
August 2007, Volume 293, Number 2, pages E558-E565.

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The objectives of the research were: 1) to evaluate the effects of different types of acidosis on neurological functions, and 2) to assess whether increased acidity or d- or l-lactate results in neurological disturbances. Researchers installed catheters in 8 Holstein calves ages about 32 days (plus or minus 11 days), and infused in the animals with isotonic dl-lactic acid, l-lactic acid, hydrochloric acid, or a saline solution. Infusions into the blood via the jugular vein were carried out randomly for a period of 6 hours. Every hour, blood from the jugular vein (other side) and cerebrospinal fluid from the atlanto-occipital space, just above the neck of the animal were sampled. The authors observed that infusing dl-lactic acid during 4 hours resulted in ataxia and decreased the activity of the central nervous system. The other infusions did not result in ataxia and did not affect the central nervous system. Hydrochloric acid caused the highest level of acidemia, followed by dl-lactic acid, l-lactic acid and the saline solution. The effects on the cerebrospinal fluid were similar but with less amplitude. The infusion of hydrochloric acid resulted in a severe acidemia and cerebrospinal fluid acidosis, but only minor alterations of the neurological functions. Infusing l-lactic acid resulted in only minor neurological effects. This implies that, independently of acidosis, neurotoxicity is caused by d-lactate.

29 Effect of isoflupredone acetate with or without insulin on energy metabolism, reproduction, milk production, and health in dairy cows in early lactation

Journal of Dairy Science, September 2007, Volume 90, Number 9, pages 4181-4191.

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The objective of this project was to assess the effect of providing isoflupredone acetate (with or without insulin) during early lactation on the following cattle parameters: milk production, reproductive performance, blood electrolytes, and energy metabolism. Researchers worked with a total of 1,162 Holstein dairy cows and first-lactation heifers from 24 dairy farms located near Guelph, in Ontario, Canada. Between the day of calving and 8 days in milk, the animals were randomly given one of 3 treatments : cows in control group received an injection of sterile water, cows from experimental group A received an intramuscular injection of 20 milligrams of isoflupredone with 100 units of insulin, cows from experimental group B received an intramuscular injection of 20 milligrams of isoflupredone alone. Serum samples were collected on the moment of the treatment, and then 7 days and 14 days after. Those samples were tested for potassium, sodium, chloride, calcium, glucose, nonesterified fatty acids, and β-hydroxybutyrate. The treatments had no influence on test-day milk production, milk fat and protein ratios, intervals from calving to first insemination or pregnancy, and on serum concentration of chloride, sodium and potassium. One week after treatment, isoflupredone acetate (with or without insulin) resulted in an increase of β-hydroxybutyrate and nonesterified fatty acids, and in a decrease of calcium. There was also a decrease of blood glucose but only for cows of the experimental group A (isoflupredone with insulin). Researchers observed an increase in the number of cases of subclinical ketosis for that same group over the period of the experiment (2 weeks). This study demonstrated that routine treatment of early lactation cows with isoflupredone acetate alone or in combination with a long acting insulin, offered no metabolic, production, or reproductive benefit in lactating dairy cattle. Based on this study, treatment of clinically healthy early lactation dairy cows with isofupredone +/- long acting insulin cannot be supported.

30 Evaluation of underlying risk as a source of heterogeneity in meta-analyses: A simulation study of Bayesian and frequentist implementations of three models

Preventive Veterinary Medicine, September 2007, Volume 81, Number 1-3, pages 38-55.

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There is an increasing use of meta-analysis in veterinary medicine as a tool for combining data from several research studies. One common application is the evaluation of disease control procedures. However, it is well known that the level of disease in the non-treated group (ie the underlying risk) may affect the estimate of the value of the treatment and contribute to variation in treatment effect estimates between studies (referred to as heterogeneity). Using a simulation study, the authors evaluated three statistical models with both Bayesian and frequentist estimation methods to evaluate the effect of underlying risk on heterogeniety. Two of the three models worked well while the 3rd was less reliable because it produced biased estimates for some parameters. Overall, results were similar using either Bayesian or frequentist methods. The study makes recommendations about the choice of model and estimation approach. When there is evidence of heterogeneity in a meta-analysis, the contribution of underlying risk to that heterogeneity should be evaluated suing one of the recommended procedures.

31 Natural and experimental infection of neonatal calves with *Clostridium difficile*

Veterinary Microbiology, September 2007, Volume 124, Number 1-2, pages 166-172.

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Clostridium difficile is a bacterium that causes severe enteric diseases and diarrhea in humans, and it has been recently associated with diarrhea in young dairy calves in Canada. The objective of this study was to administer orally toxigenic *Clostridium difficile* (PCR-ribotype 077) to newborn calves and to study whether it would result in the development of enteric disease or diarrhea. Researchers worked with 14 newborn male Holstein calves that had been fed adequate amounts of colostrum. A control group of 6 calves received a sterile culture mix while 8 other calves in the experimental group were given 3 doses of *Clostridium difficile*. Euthanasia was done 6 days after the administration of the bacterium, or after the onset of diarrhea whichever came first. Overall, the oral administration of toxigenic *Clostridium difficile* (PCR-ribotype 077) to newborn calves produced colonization of feces and intestines. However, there were no clinical signs of enteric disease or *C. difficile* associated diarrhea and no *C. difficile* toxins were detected in the feces of the infected calves. Researchers also identified the caecum (first part of the large intestine) as a frequent site of residence for *C. Difficile*. The study concluded that more research is needed to assess the relevance of *Clostridium difficile* in calves.

5 Herd Management

1 An evaluation of two indirect methods of estimating body weight in Holstein calves and heifers

Journal of Dairy Science, October 2006, Volume 89, Number 10, pages 3992-3998.

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Since it is not always possible for milk producers to have readily access to an electronic scale when they want to measure body weight of heifers, this research was conducted to evaluate the efficacy of two indirect methods to estimate that weight. The first method is the hipometer, a new tool that looks like large scissors and that may be used to estimate body weight by measuring the distance between the animal's hips, more precisely between the outer protuberances of the right and left femurs. The second method is the « heart girth tape », a measuring tape that is used to establish the circumference of the animals just behind the front legs. There is a known statistical relationship between the dimension of heart girth and body weight. For the purpose of the study, a total of 311 Holstein heifers were separated in 4 groups, their age ranging from 1 week old to just prior to 24 months old. Readings from the hipometer and the heart girth tape were compared with those from the accurate electronic scale and were found to correspond closely, in particular for animals aged between 3 and 15 months. The study concluded that the hipometer is an easy and useful tool to estimate body weight in Holstein heifers, especially in heifers aged from 3 to 15 months. For animals less than 3 months old or over 15 months old, the hipometer's readings are less in accordance with results from accurate instruments like a scale. One limitation of the hipometer is that the instrument is not designed to be used with larger animals such as lactating cows.

6 Milk Production

1 Effect of stage of lactation and parity on mammary gland cell renewal

Journal of Dairy Science, December 2006, Volume 89, Number 12, pages 4669-4677.

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The purpose of this study is to analyze the factors affecting the mammary gland of multiparous cows (having calved several times) and primiparous cows (having calved only once). Biopsies were taken on mammary glands during various stages of lactation (10, 50 and 250 days in milk) in order to evaluate gene expression and establish DNA and fatty acid synthase (FAS) content. During the day before the biopsies, milk samples were taken and used to detect protease activities and to establish stanniocalcin-1 (STC) concentrations. Blood samples were also taken to measure insulin-like growth factor-1, prolactin and STC concentrations. The study found that milk production was higher in multiparous cows compared to primiparous cows at both 10-day and 50-day stages of lactation, whereas it was the same after 250 days of lactation. The stages of lactation did not affect the expression of genes related to milk synthesis, except for stearoyl-coenzyme A desaturase, but gene expression of acetyl-coenzyme A carboxylase, o-casein and FAS was lower in primiparous cows after 10 days of lactation. Expression of proapoptotic bax and antipoptotic bcl-2 genes was higher in primiparous cows but the bax-to-bcl-2 ratio stayed the same. The concentration of mammary DNA and the amount of FAS protein was higher in multiparous cows after 10 days of lactation. As the stages of lactation progressed in time, there was an increase of serum insulin-like growth factor-1 and the amount was higher in primiparous cows. There was also an increase of milk STC. For primiparous cows, serum prolactin reached a peak after 10 days of lactation while that peak was reached at the 50-day mark for multiparous cows. On both groups of cows, prolactin was lower at the 250^{th} day of lactation. The study concludes that mammary glands of primiparous cows have a greater capacity for cell renewal and a lower degree of differentiation.

2 Abundance and phosphorylation state of translation initiation factors in mammary glands of lactating and nonlactating dairy cows

Journal of Dairy Science, June 2007, Volume 90, Number 6, pages 2726-2734.

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The objective of this study was to test the hypothesis that control of mRNA translation is involved in the increase of milk protein synthesis during lactation. In the experiment, scientists studied a total of 12 nonpregnant dairy cows. During 42 days, 6 cows in late lactation continued to be milked as usual and the other 6 were completely dried off. After the cows were slaughtered, samples of mammary glands and tissue were taken from the animals. It was found that alveoli and lobules tended to be larger in milked cows compared to dried off cows. Also, cell number, cell size, mammary parenchymal mass, RNA, DNA and protein contents were greater in milked cows compared do dried off cows. Active phosphorylated ribosomal protein S6 was 3.1 times higher and its kinase S6K1 was 1.8 times higher in milked cows compared to dried off cows. Cellular abundances of the main eukaryotic translation initiation factors eIF2 and eIF4E were higher by 2.6 and 3 times respectively in milked cows. The amount of phosphorylated rpS6 was the same between mammary parenchyma and liver, but it was 50 % higher in mammary tissue. In semimembranous muscle, the amount of phosphorylated rpS6 and eIF2I was 3 to 4 times lower than in mammary parenchyma. In mammary glands of both milked and dried off cows, 11 % of eIF2I was in the inhibitory phosphorylated form while 48 to 60 % of eIF4E was complexed with its binding protein 4EBP1. The study concludes that upregulation of initiation factors of mRNA translation occurs in the fully differentiated milk secretory cell and that, in the case where crucial initiation factors are not present in a maximally form, the initiation rate may be flexible in response to external stimuli.

7 Nutrition

1 Effects of source of rumen fluid on *in vitro* dry matter digestibility of feeds determined using the DAISY (II) incubator

Canadian Journal of Animal Science, December 2006, Volume 86, Number 3, pages 439-441.

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Scientists have developed a new method for evaluation of dry matter digestibility as a possible replacement of the 45-year old conventional method of Tilley and Terry. The new method provides a higher degree of precision and labour efficiency. With the Daisy (II) incubator, manufactured by ANKOM Technology Corp. (Macedon, NY, USA), it is possible to incubate up to 100 feed samples in special filter bags placed in four digestion chambers. Previous studies had suggested that determining apparent in vitro dry matter digestibility using the DAISY (II) incubator and the Tilley and Terry method resulted in the same values. In this experiment, researchers used the DAISY (II) incubator, to test the digestibility of 12 cattle feeds. The objectives were to compare apparent (ADD) and true (TDD) in vitro dry matter digestibility using inoculum from ruminal fluid obtained from cattle fed grass hay or fed total mixed ration (56 % forage and 44 % grain), and to determine if the source of inoculum affected the digestibilities. Grass hay was fed ad libitum to 3 rumen-cannulated Jersey steers, and total mixed ration was also fed ad libitum to four rumen-cannulated Holstein cows. The study found that inoculum had no effect on the digestibility of ADD and TDD. When averaged across feeds and sources of inoculum, ADD digestibility was lower by 6.7 % compared to TDD.

2 *In vitro* ruminal digestion of anthocyanidin-containing alfalfa transformed with the maize Lc regulatory gene

Canadian Journal of Plant Science, October 2006, Volume 86, Number 4, pages 1119-1130.

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Alfalfa is the world's most used forage crop for cattle; it is also the most desirable. Unfortunately, the decomposition of alfalfa in the cattle's digestive track often results in annoying bloating. This can be controlled by introducing proanthocyanidins-containing forages in the fields of alfalfa forage but this solution is difficult to apply because the competition between different forages limits the viability of a mixed pasture. The ideal solution would be to create a new type of alfalfa that contains the desire anti-bloating substances, i.e. proanthocyanidins. For this experiment, researchers used a recently created transgenic alfalfa that contains the LEAF COLOUR (Lc) gene, which induced flavonoids and proanthocyanidin in the plant. The Lc-transgenic (modified) genotypes of alfalfa were compared to regular alfalfa for *in vitro* ruminal fermentation, dry matter and nitrogen disappearance, and dry matter degradability. The modified alfalfa expressed the Lc gene differently when exposed to high intensity lighting, this resulted in anthocyanidin contents of up to 136 micrograms g-1 DM. Modified alfalfa had lower true dry matter disappearance than regular alfalfa at zero, four and 12 hours of incubation but not at 24 and 48 hours. Modified alfalfa had a lower content of rapidly soluble dry matter, compared to regular alfalfa. However, the content and rate of degradation of the slowly degradable dry matter fraction was similar. The lag time for digestion was also similar. At the beginning of the incubation, true disappearance of nitrogen was lower for modified alfalfa than for regular alfalfa. There was a negative correlation between the solubility of dry matter and nitrogen with the concentration of anthocyanidins present in the forage. The study concludes that modification of alfalfa using the Lc-transformation process resulted in a reduction of the initial rate of digestion of alfalfa in the rumen, but it did not reduce the extent of dry matter and nitrogen digestion.

3 Effects of fat coated rumen bypass lysine and methionine on performance of dairy cows fed a diet deficient in lysine and methionine

Animal Science Journal, October 2006, Volume 77, Number 5, pages 495-502.

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This study comprises two experiments conducted to assess the effect of fat coated rumen bypass lysine (RPLys) and methionine (RPMet) on the lactation productivity of dairy cows. In experiment # 1, researchers took 3 lactating cows and gave them RPLys and fat coated DL-Met. The last product was highly protected as an indigestible marker (H-RPMet). Fecal emissions were collected for a period of 72 hours following administration of the products. The proportional difference between fecal excretion of lysine and methionine was measured and the results estimated an intestinal availability of RPLys of 66.2 %. In experiment # 2, a total of 20 multiparous Holstein dairy cows producing about 40 kilograms of milk on a daily basis received 2 treatments in the period from 5 to 21 weeks after calving : one group was fed with RPLys (16 grams/day of lysine) and RPMet (6.5 grams/day of methionine) and the other group was the control so they were not fed with the treatments. Results indicated that the intake of dry matter, organic matter, crude protein, neutral detergent fiber and acid detergent fiber was significantly higher in the control group during the complete period of the experiment. Cows having received the treatments had higher milk productivity and the milk from those cows had a higher content of milk protein (0.06%) and milk fat (0.11%). The study concludes that both RPLys and RPMet used in these 2 experiments improved the lactation productivity of dairy cows.

4 Effect of casein and propionate supply on mammary protein metabolism in lactating dairy cows

Journal of Dairy Science, November 2006, Volume 89, Number 11, pages 4340-4351.

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Researchers took 3 multiparous Holstein dairy cows fitted with duodenal and ruminal cannulas and evaluated them over six 14-day periods to see the effect of casein (743 grams/day in the duodenum) and/or propionate (1041 grams/day in the rumen) on mammary amino acids (AA) metabolism. During each period, L-[1-^{13}C]Leu(d11) and NaH[^{13}C]O_3(d13) were infused into a jugular vein and blood samples were taken from both the carotid artery and the mammary vein in order to evaluate Leu kinetics and net uptake of AA. Both casein and propionate treatments increased milk protein concentration and yield, but casein at a greater extent. In regard to casein infusion, it induced a general response in mammary protein metabolism. There was an increase in Leu net uptake (30%), the uptake: output ratio (8%), protein synthesis (11%), secretion in milk protein (21%) and oxidation (259%). Propionate treatments resulted in an increase of only Leu as milk protein (7%) and when combined with casein, it tended to reduce Leu used for protein synthesis (5%). During all the treatments, most of the mammary Leu uptake was recovered as Leu in milk protein or oxidized, and the Leu balance was achieved without involving peptide use or production. There was an increase in the mammary uptake of group 1 AA to match milk output with all infusions. On the contrary, the mammary uptake of group 2 AA exceeded output more with casein than with propionate infusions. The study concludes that, when protein or energy is supplied, different mechanisms are responsible for the increase of milk protein production.

5 Exogenous enzymes added to untreated or ammoniated rice straw: Effects on *in vitro* fermentation characteristics and degradability

Animal Feed Science and Technology, November 2006, Volume 131, Number 1-2, pages 87-102.

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In recent years, there has been an increased interest in using rice straw to feed ruminants in several countries of Asia. The reason behind this is the high cost of good quality forage and the abundance of rice straw in that part of the world. However, rice straw has a low nutritive value because of its limited ruminal digestibility. The objective of this study was to determine if the digestibility of rice straw could be enhanced by treating it with fiber-digesting enzymes, and to determine whether the use of enzymes to enhance digestibility resulted in improvements similar to those obtained by ammoniation of straw. Researchers tested two developmental cellulases, two developmental xylanases, one commercial enzyme supplying a combination of cellulases and xylanases, and, finally, one commercial enzyme supplying mostly proteases, in order to assess their effect on *in vitro* degradation of untreated or ammoniated rice straw. The ruminal digestion of dry matter, neutral detergent fibre, acid detergent fibre and volatile fatty acid production were assessed after 24 hours of incubation. It was found that ammoniation greatly increased gas production and digestion of rice straw. The two commercial enzyme products also increased gas production and digestion of untreated rice straw. On the contrary, the developmental enzymes had little effect on untreated rice straw. As for the ammoniated rice straw, the action of xylanases resulted in increased gas production beginning at 18 hours of fermentation, and also dry matter and fibre decomposition at 24 hours. The two commercial enzyme products also increased gas production and fibre digestion, but the enzyme supplying both cellulases and xylanases had a greater effect. The study concludes that the combination of exogenous enzymes and ammonia treatment resulted in an increase of ruminal degradation of rice straw.

6 Comparison of net portal absorption with predicted flow of digestible amino acids: Scope for improving current models ?

Journal of Dairy Science, December 2006, Volume 89, Number 12, pages 4747-4757.

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The objective of this study was to evaluate the relationship between measured net portal absorptions and flows of digestible essential amino acids predicted with 2 models. The first model comes from the National Research Council and the second from the University of Cornell (Ithaca, New York State, USA). It was possible to obtain net portal absorption data using 33 measurements of portal-arterial plasma EAA concentration differences among 8 treatments in lactating dairy cows. The plasma flow was estimated from downstream dilution of para-amino-hippurate. It was found that predicted digestible flows from the National Research Council's model was more accurate than the other model in regard to the actual observation in this experiment. A factorial method was also used to estimate the flows of digestible EAA, assuming an AA composition for each fraction of the duodenal flow estimated by the National Research Council's model (undergradable, microbial, and endogenous proteins). Based on literature values, researchers suggest an increase of the digestibility of the undergradable fraction of forages and of microbial protein in order to improve the relationship between predicted digestible flows and net portal absorptions. This study concludes that, across EAA, there is an indirect confirmation of smaller losses through gut metabolism for His, Met and Lys, intermediate losses for the branched-chain AA and the higher loss for Thr.

7 Effects of rumen acid load from feed and forage particle size on ruminal pH and dry matter intake in the lactating cow

Journal of Dairy Science, December 2006, Volume 89, Number 12, pages 4758-4768.

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This study was done to evaluate the effect of acidogenic value diets and forage particle size on ruminal acidity (pH) and feed intake in lactating dairy cows. In this experiment, four rumen-fistulated dairy cows were randomly given one of the four treatments during 3-week periods (14 days for adapting the animal to the treatment, followed by 7 days for collecting the data). Researchers used two concentrates having either a low of high acidogenic value and they included those concentrates in total mix ration with coarsely or finely chopped corn silage and alfalfa haylage. The cows were fed ad libitum with that diet. It was found that an increase of the concentrate acidogenic value resulted in a decrease of the mean pH (from 6.07 to 5.97) and also of the minimum pH (from 5.49 to 5.34). An increase of the acidogenic value diet had no effect on the dry matter intake but it resulted in a reduction of neutral detergent fiber intake from 9.7 to 8.8 kilograms per day. It also lowered the mean pH value from 6.07 to 5.97, and the minimum pH value from 5.49 to 5.34. Also, cows fed with high-acidogenic value diet spent more time below pH 5.6 (236.7 minutes per day) and pH 5.8 (480.6 minutes per day) compared to those fed with low acidogenic value diet (135.1 minutes and 290.0 minutes per day respectively). The study concludes that coarse forage particle size can decrease drops in ruminal pH but the benefits from forage particle size on drops in ruminal pH were more visible for high-acidogenic value diets compared to low-acidogenic value diets.

8 Effects of rumen-protected choline and monensin on milk production and metabolism of periparturient dairy cows

Journal of Dairy Science, December 2006, Volume 89, Number 12, pages 4808-4818.

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The objective of this study was to provide transition dairy cows with a supplement of monensin and choline in order to evaluate the effects of those supplements on metabolism, dry matter intake, milk production and liver function. A total of 182 Holstein dairy cows were randomly selected to receive either monensin (in a controlled-release capsule), 56 grams per day of rumen-protected choline (until 28 days in milk), both monensin and choline, or no supplement at all (control group). Blood samples were collected 4 times during the experiment: at the beginning of the study, 1 week before calving, 1 week after calving, and 2 weeks after calving. Also, liver biopsies were taken on randomly selected multiparous cows from each treatment group within 24 hours and 3 weeks after calving. A recording was made of daily milk production until 60 days in milk. There was no interaction of the effects of choline and monensin on any of the assessed parameters. Overall, during the first 60 days of lactation, there was an increase in milk production of 1.2 kilograms per day among cows that received choline. However, this result was due to cows with high body condition (body condition >= 4 at 3 weeks before calving) that received choline as that group of animals ate more dry matter (1.1 kilogram more per day) during the period from 3 weeks before calving to 4 weeks after calving. These overconditioned cows that received choline produced 4.4 kg more milk per day than cows that did not receive choline. It was also found that monensin increased serum concentrations of glucose and urea, and decreased concentrations of beta-hydroxybutyric acid and aspartate aminotransferase in the post-calving period. Monensin also increased liver glycogen content at 3 weeks of lactation. The study concludes that the effects of monensin are similar to the results obtained in previous studies, and that this experiment could not explain why the treatment with choline resulted in an increase of milk production.

9 Effects of protein supply on hepatic synthesis of plasma and constitutive proteins in lactating dairy cows

Journal of Dairy Science, January 2007, Volume 90, Number 1, pages 352-359.

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The objectives of this study were to evaluate 1) the rate of plasma protein synthesis, 2) the maximum proportion of net hepatic removal of phenylalanine (Phe) that can be used by the liver for synthesis of export proteins, 3) the maximum proportion of hepatic protein synthesis directed toward export proteins, compared to constitutive proteins 4) how protein supply affect these parameters. Three different total mixed rations were formulated to provide the same amount of energy but different amounts of metabolizable proteins: 1922 (low), 2264 (medium) and 2517 (high) grams per day. The diets were given every 2 hours to 6 multicatheterized Holstein lactating dairy cows. For the low and high treatments, on day 21 of each period, the cows were infused for 8 hours on a continuous basis with [$^{2}H_{5}$]Phe (d5-Phe) in a jugular vein (1.3 millimoles per hour). Samples were collected every hour between 3 and 8 hours of the infusion, followed by measurement of concentration and isotopic enrichment of d5-Phe for free plasma Phe, plasma total proteins, and albumin. Low metabolizable protein supply lowered the plasma albumin concentration but the plasma protein concentration remained unchanged. The fractional and absolute synthesis rates of plasma proteins or albumin were not affected by the metabolizable proteins. The low-metabolizable protein diet resulted in a lower net hepatic removal of Phe, leading to a higher proportion of net hepatic Phe removal used for total export protein synthesis and albumin synthesis. The study concludes that hepatic synthesis of plasma proteins, including albumin, seems to be maintained in lactating dairy cows despite a reduction in protein supply.

10 Severity of ruminal acidosis in primiparous Holstein cows during the periparturient period

Journal of Dairy Science, January 2007, Volume 90, Number 1, pages 365-375.

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This study was done 1) to evaluate the effect of supplying additional prepartum concentrate on the rate and severity of ruminal acidosis and lactation performance during the periparturient period of primiparous cows, 2) to better understand the rate and severity of ruminal acidosis in the periparturient period. A total of 14 rumen-cannulated Holstein heifers were used in this experiment. The heifers were given one of the following : A) a far-off diet (forage:concentrate ratio of 80:20) fed beginning at 60 days until 25 days prior to calving, and a close-up diet (forage: concentrate ratio of 54:46) from 24 days before calving until the birth of the calf, or B) a high-concentrate of 4 different prepartum diets scheduled as follows: diet # 1 (forage:concentrate ratio of 68:32) was given from 60 days until 43 days prior to calving, diet # 2 (forage:concentrate ratio of 60:40) was given from 42 days until 25 days before calving, diet # 3 (forage:concentrate ratio of 52:48) from 24 days until 13 days before calving and, finally, diet # 4 (forage:concentrate ratio of 46:54) ended the program from 12 days until the birth of the calf. The postpartum lactation diet was the same for all the cows. Ruminal acidity (pH) was evaluated continuously from 5 days before until 5 days after calving, and for 3 consecutive days at 17, 37 and 58 days after calving. Ruminal acidosis was considered to be present when the pH reading was 5.8 or lower. Furthermore, ruminal acidosis was broken down in 3 categories: mild (pH reading between 5.5 and 5.8), moderate (pH reading between 5.2 and 5.5) and severe (pH reading below 5.2). It was found that feeding additional concentrate before calving did not reduce ruminal acidosis after parturition. On the contrary, cows that had the 4 prepartum diets showed a higher daily rate of severe ruminal acidosis. The study concludes that postpartum ruminal acidosis is not reduced by feeding additional concentrate prepartum. Also, the rate and severity of ruminal acidosis increased immediately after calving, suggesting the need to develop feeding strategies that reduce acidosis in heifers once they calve.

11 Technical note: A system for continuous recording of ruminal pH in cattle

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In order to measure the acidity level (pH) inside the rumen, a sensor has to be installed inside the animal, with cables connecting the sensor to the recording equipment in the laboratory. Those cables prevent the animals from moving during the experiments. Therefore, the objective of this project was to develop a continuous ruminal pH reading system that allows the animals some mobility. Also, researchers wanted to see if the readings from that equipment would compare to those of spot sampling. The new system consisted of a heavy-duty electrode and a data recorder. A 0.5-kilogram weight was attached to the electrode to help keeping it in the ventral sac of the rumen. Using a 0.5-meter electrical cable, the electrode was connected to a lightweight data recorder that was attached on the back of the cow with a belt wrapped around the girth. The data recorder was powered by a battery and was able to contain over 13,000 pH data readings. The configuration and downloading of the data from the recorder was done with a personal digital assistant (PDA). During 3 days, ruminal acidity (pH) was continuously recorded every 10 seconds on a Holstein cow fed with alfalfa hay ad libitum. Three replicate spot samples were collected 3 times per day during 3 days. Using a handheld pH meter, readings were done immediately, averaged and compared to those of the continuous system. It was found that pH values from spot sampling were slightly greater than those of the continuous system (6.63 vs. 6.56). The study concludes that the portable, continuous ruminal pH measurement system can make it easier to read ruminal acidity of free roaming cows.

12 Assessment of the efficacy of varying experimental exogenous fibrolytic enzymes using *in vitro* fermentation characteristics

Animal Feed Science and Technology, January 2007, Volume 132, Number 3-4, pages 298-315.

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The objective of this study was to evaluate, in two laboratory experiments, single activity experimental enzymes (including 13 endoglucanases and 10 xylanases) for their potential to increase in vitro ruminal digestion of alfalfa hay. Enzymes were added to alfalfa hay in culture vials (6 replications). An anaerobic buffer medium with pH adjusted to 6.0 and strained ruminal fluid were then added to the vials and incubated for 18 hours. Digestion of organic matter plus fibre and volatile fatty acid concentrations were measured after 18 hours while gas production was measured throughout the incubation. The enzymes contained various amounts of added endoglucanases (i.e., cellulases) or xylanases. It was found that, in experiment # 1, many endoglucanases and some xylanases increased gas production and organic matter digestion. Two of the endoglucanases and two other xylanases were chosen to be included in experiment # 2 because of their beneficial performance on feed digestion. For the second experiment, all of the enzymes (alone or in combination) were found to increase gas production and organic matter digestion. However, combining the endoglucanases and xylanases had no additional beneficial effects on the digestion of alfalfa beyond what could be expected from the individual component enzymes. The total production of volatile fatty acid remained the same throughout the experiments but some enzyme products changed the acetate to propionate ratio. The study concluded that some experimental enzyme products with either endoglucanase or xylanase activity increase in vitro ruminal digestion of alfalfa hay, but the improvements are enzyme product specific.

13 Ruminal degradability and intestinal digestibility of protein and amino acids in treated soybean meal products

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The objective of this study was to evaluate the effect of various methods of treating soybean meal on the ruminal degradability and intestinal digestibility of crude protein and amino acids. In this experiment, researchers used four lactating dairy cows equipped with ruminal and duodenal cannulas. Four different types of treated soybean meals were incubated in the rumen of the animals: a solvent-extracted soybean meal, an expeller soybean meal, a lignosulfonate soybean meal, and a heat/soyhulls soybean meal. Those substances were put in nylon bags inside the rumen for 48, 24, 16, 8, 4, 2 and 0 hours, in accordance with the 2001 guidelines of the National Research Council. More samples of each soybean meal were also incubated in the rumen during 16 hours and the residues were transferred in other bags before being soaked in pepsin hydrochloric acid to assess their intestinal digestibility. It was found that expeller, lignosulfonate and heat/soyhulls treatments protected the crude protein and amino acids from ruminal degradation. The amount of amino acids was always higher (+30 %) with treated soybean meals compared to solvent-extracted soybean meals. Among the treated soybean meals, there was a difference in the availability (rumen undegradability * intestinal digestibility) of four essential amino acids (Ile, Leu, Phe, and Val) with values always lower for heat/soyhulls soybean meals compared to lignosulfonate soybean meals. The study concluded that, based on this experiment's measures, amino acids availability is increased when soybean meals are treated with heat and chemicals. It also concluded that expeller and lignosulfonate soybean meals had a greater potential than heat/soyhulls to increase amino acids supply to the small intestine of high-producing dairy cows.

14 Milk from forage as affected by rumen degradable protein and corn grinding when feeding corn and alfalfa silage-based diets

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Milk from forage is an estimation of the milk produced solely from forage intake. High milk from forage has been shown of economic interest for dairy farms in Quebec. The objective of this study was to determine the effect on milk from forage of using varying complementary combinations of concentrates in an alfalfa and corn silage-based diet. In this experiment, researchers evaluated 8 multiparous Holstein dairy cows in early lactation over a period of 3 weeks. Total mixed rations were prepared with corn and alfalfa to provide equal levels of energy for lactation and crude protein but with different rumen degradable protein content. The result was four different feed treatments: 1) cracked corn-based concentrate with low rumen degradable protein (11.1% dry matter) as recommended by the National Research Council in 2001; 2) cracked corn-based concentrate with medium rumen degradable protein (12.8% dry matter); 3) cracked corn-based concentrate providing high rumen degradable protein (14.5 % dry matter); 4) ground corn-based concentrate providing high rumen degradable protein (13.6% dry matter). Scientists compared the first 3 treatments (cracked corn) and found that, on average and when calculated on a protein basis, milk from forage decreased, and so did milk production (from 32.8 to 30.7 kilograms per day) and milk protein (from 1094 to 1005 grams per day) as rumen degradable protein increased. There was no change in milk fat production but the level of milk urea nitrogen increased as the rumen degradable protein increased. There was no change in the milk from forage when it was calculated on an energy basis. For treatments # 3 and 4, ground corn provided better results on milk and protein production, as well as milk from forage calculated on a protein basis, than cracked corn. The study concludes that, when alfalfa and corn silage are used together, there is no benefit of feeding dairy cows more rumen degradable protein than what is recommended by the National Research Council. Also, there is a benefit of feeding ground corn in the diet even when corn silage is used.

15 Effects of prepartum administration of a monensin controlled release capsule on rumen pH, feed intake, and milk production of transition dairy cows

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The main objective of this project was to evaluate the effect of providing monensin in a controlled release capsule during prepartum on rumen acidity (pH), dry matter intake and milk yield of dairy cows during transition and early lactation. Researchers studied 16 multiparous Holstein dairy cows over transition and early lactation periods. After placing them in groups of 2 according to calving dates, they fed the animals ad libitum with one of the following: a close-up dry cow ration or a lactating cow total mixed ration. Internal measurement probes were used for continuous monitoring of rumen pH. It was found that, over the duration of the experiment, monensin had no effect on average daily rumen pH, time and area passed below pH 6 or below 5.6. Before calving, the values of average daily pH and time passed below pH 6 and 5.6 were stable at 6.62, 65.6 minutes per day and 17.6 minutes per day respectively. One week after calving, those values were 6.19, 443.3 minutes per day and 115.5 minutes per day respectively while, six weeks after calving, they were 6.36, 204.3 minutes per day and 52.4 minutes per day respectively. Following calving, average daily pH increased significantly while time passed below pH 6 decreased by the same order of magnitude, and time passed below pH 5.6 decreased linearly. Dry matter intake and daily production of milk, milk fat, and milk protein were not affected by monensin. The study concludes that, for multiparous dairy cows fed with the diets used in this experiment, providing monensin in a controlled release capsule during prepartum does not increase rumen pH over the transition and early lactation periods.

16 The effect of formulation and amount of potassium fertilizer on macromineral concentration and cation-anion difference in tall fescue

Journal of Dairy Science, February 2007, Volume 90, Number 2, pages 1063-1072.

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Milk fever is a disease that affects dairy cows after calving. It has negative effects on milk production and requires veterinary treatments. Previous research has shown that increasing the level of dietary anions in the cow's diet decreases blood and urine acidity (pH) and helps to protect the animals against milk fever. The objective of this study was to evaluate the possibility of modifying the cation-anion difference of grass by changing the quantity and recipe of potassium fertilizer. Two experiments were done: in the first, a set of treatments were developed using Barcel and Hi-Mag varieties of tall fescue, 0 and 250 kilograms of potassium chloride per hectare, and 0 and 60 kilograms of magnesium oxide per hectare. In the second experiment, the potassium was applied at 0 and 125 kilograms per hectare in the form of either potassium chloride or sulphate to Hi-Mag tall fescue. As a result of these experiments, the cation-anion ratio of grass increased following by the application of potassium fertilizer and this effect was more detectable in Barcel tall fescue than in Hi-Mag. Also, the cation-anion difference of grass was higher in Hi-Mag fertilized with potassium chloride compared to Hi-Mag fertilized with potassium sulfate. The study concludes that it is possible to modify the cation-anion difference of grass by a selection of grass varieties, fertilizer formulation and application rate.

17 A review of the detection and fate of novel plant molecules derived from biotechnology in livestock production

Animal Feed Science and Technology, February 2007, Volume 133, Number 1-2, pages 31-62.

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Since their introduction in 1996, transgenic crops have been the subject of controversy in the public but it was nevertheless adopted rapidly by the farming industry. Between 1996 and 2004, the total land area dedicated to genetically modified crop has increased over 47 times and reached 81 million hectares in 2004. One of the main concerns is the injection of recombinant DNA and proteins in the food chain. Because livestock such as dairy cows eat lots of forage and plants, they are subject to ingesting important quantities of genetically modified crops. Therefore, the purpose of this study was to make a review of the techniques for detecting transgenic material in livestock feeds, and the consequences for livestock of ingesting recombinant proteins and DNA. The techniques for detecting and measuring the quantity of genetically modified crops in the feeds include assay of protein and DNA. No transgenic protein has been found in animal products or tissues. However, pieces of DNA from endogenous high-copy genes from plants were found in tissues of farm animals such as ruminants, pigs and poultry. Scientists also detected lower levels of low-copy endogenous and transgenic DNA in animal tissues. According to researchers, it is a normal and natural process for DNA parts to pass through the intestinal walls. Of course, the more DNA there is in the food, the more chances this will happen. The present study concludes that, as of today, after 12 years of use, there are no indications that transgenic crops have been a safety problem for livestock.

18 Predicting the profile of nutrients available for absorption: From nutrient requirement to animal response and environmental impact

Animal, February 2007, Volume 1, Number 1, pages 99-111.

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In this study, the authors discuss the change that needs to take place in the industry to move from a system based on feed requirements to another system based on the response of the animals to feeds. The latter is considered to be more in accordance with the needs of stakeholders as it becomes possible to predict responses to dietary changes, excretion in the environment, and disorders related to nutrition. However, this change requires a knowledge base of absorbed nutrients and their subsequent uses in the animals' bodies. For dairy cattle, the challenges are many. Because fatty acids (volatile and long-chain), amino acids and glucose are some of the nutrients of interest, a better understanding of reticulo-rumen processes is of prime importance. There is also a lot of research being done on rumen fermentation in order to assess the degradation rate of feeds inside the rumen; future research should focus more on the rates of passage of nutrients out of the rumen. Another important topic of research should be microbial metabolic variation, as recent studies have shown that knowledge is deficient in that domain, and more especially in the domain of protozoal metabolism. This particular field of study requires close collaboration between nutritional scientists, molecular scientists and mathematical specialists for modeling quantitative data. Models need also to be developed to assess the mitigation strategies for animal waste such as nitrogen, phosphorus and methane. This study concludes that, because of an increase of interest from the public and governments for environmental questions, the development of new mechanistic models based on nutrients will be stimulated.

19 Use of exogenous fibrolytic enzymes to enhance *in vitro* fermentation of alfalfa hay and corn silage

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There were 3 objectives in this experiment: 1) evaluate the in vitro digestion of alfalfa hay and corn silage using exogenous fibrolytic enzymes, 2) identify the ideal dose rates of each exogenous fibrolytic enzyme product, 3) find the link between the added enzymatic activities and fiber digestion. For experiment # 1, five exogenous fibrolytic enzyme products (comprising mostly endoglucanase and xylanase in various proportions) were evaluated at 0.7, 1.4 and 2.1 milligrams per gram of dry forage. Alfalfa hay and dried corn silage were milled and incubated in vitro with a buffer, ruminal fluid and the enzymes. Measurement of gas production was made during the whole incubation period (24 hours) whereas dry matter digestion was assessed after the 24-hour incubation period. It was found that, of the 5 enzymes evaluated, 2 of them (E1 and E3) were especially effective in increasing gas production and dry matter digestion. The ideal dose rate was found to be 1.4 milligrams per gram of forage for both alfalfa and corn. This dose resulted in up to a 20.6% increase in the digestion of neutral detergent fiber from alfalfa, and an increase of up to 60.3% for the digestion of corn silage fiber. Those 2 enzymes were again evaluated in experiment # 2, but this time the 2 enzyme products were mixed with a high xylanase enzyme to see if their activity could be increased by lowering the ratio of endoglucanase to xylanase. The results were the same to those of experiment # 1 so the added xylanase activity in experiment # 2 did not improve the performance. The study concludes that forage digestion in the rumen is greatly improved when some exogenous fibrolytic enzymes are used, but it is critical to provide an adequate dose and the right enzyme activities.

20 Intake, whole tract digestibility, milk production, and milk composition of Holstein cows fed extruded soybeans treated with or without lignosulfate

Animal Feed Science and Technology, March 2007, Volume 134, Number 1-2, pages 32-44.

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The objective of this experiment was to evaluate the effect of extruded soybeans compared to non-extruded soybeans on whole tract digestibility, milk yield and composition, and milk fatty acid. Researchers used 8 multiparous Holstein lactating dairy cows during 20-day periods and fed them with both extruded and non-extruded soybeans. The soybeans were either treated or not treated with 30 grams of lignosulfate per kilogram of soybeans. It was found that milk production from the cows was the same at 20.8 kilograms per day, no matter the treatment they received. However, there was lower digestibility of dry matter, neutral detergent fiber and acid detergent fiber among cows fed with extruded soybeans, compared to those fed with non-extruded soybeans. Digestibility of dry matter, ether extract, crude protein and neutral detergent fiber was not changed when lignosulfate was added to the soybeans. Also, feeding extruded soybeans resulted in a decrease of milk fat concentration, saturated fatty acids and medium-chain fatty acid in milk fat. On the contrary, conjugated linoleic acid in milk fat increased. When lignosulfate was added to the soybeans, concentrations of cis9, trans11 conjugated linoleic acid and polyunsaturated fatty acids also increased. The study concludes that milk fatty acid composition can be changed by feeding dairy cows with extruded soybeans while the addition of lignosulfate in soybeans does not affect milk fatty acid.

21 Effects of supplementing myristic acid in dairy cows rations on ruminal methanogenesis and fatty acid profile in milk

Journal of Dairy Science, April 2007, Volume 90, Number 4, pages 1851-1858.

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Methane production from dairy cattle is a natural phenomenon resulting from fermentation of organic matter in the rumen. The average production of methane per cow is estimated to be between 80 and 100 kilograms per year. On a global scale, ruminants generate about 80 million metric tons of methane every year. Previous studies have shown that it is possible to control ruminal methane production by adding fatty acid supplements in the food, such palm kernel oil, coconut oil or canola oil. The purpose of this experiment was to assess the effects of adding a supplement of another fatty acid (myristic acid) in dairy cows diets on fatty acid characteristics of milk and ruminal production of methane. Researchers used 12 multiparous Holstein dairy cows living in a tie-stall building. The cows were given twice a day with one of the following: 1) regular total mixed ration for lactating cow (control diet), or 2) same ration as # 1 except for a supplement of 5 % myristic acid added to the dry matter. Milking was also done twice a day. It was found that adding myristic acid to the rations decreased methane production by 36 % and milk fat by 2.4 %. Myristic acid also increased cis-9 14:1 by 195 % and 14:0 in milk by 139 %. However, it had no effect on conjugated linoleic acid, trans-10 18:1 and trans-11 18:1 isomers in milk. The study concludes that adding myristic acid to dairy cows diets decreases methane production without changing the characteristics of trans-18:1 fatty acid and conjugated linoleic acid in milk.

22 Effect of monensin delivery method on dry matter intake, body condition score, and metabolic parameters in transition dairy cows

Journal of Dairy Science, April 2007, Volume 90, Number 4, pages 1870-1879.

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The objective of this study was to evaluate the effects of adding monensin, either in controlled-release capsules or mixed in the rations, on several metabolic parameters and feed intake. For this project, researchers studied 136 Holstein dairy cows. The animals were given one of the following: 1) monensin a controlled-release capsules, 2) monensin sodium premixed in the rations and dosed at 22 milligrams per kilogram of dry matter, 3) a regular diet (control group). Monensin was given to cows starting 3 weeks before expected calving. Blood samples were taken 5 times during the experiment: 3 weeks and 1 week before calving, at calving, 1 week and 2 weeks after calving. The cows' body condition was assessed at the beginning and at the end of the experiment. Daily dry matter intake values were collected over the entire study and no significant differences were observed. Blood samples were analyzed to assess the following parameters: glucose, urea, bilirubin, insulin, cortisol, aspartate aminotransferase, nonesterified fatty acids, and o-hydroxybutyrate (BHBA). Results suggest monensin supplementation resulted in a significant decrease of BHBA after calving, regardless of delivery method. Furthermore, urea concentrations increased after calving. Over the period of the experiment, the controlled-release capsules minimized body condition loss. The study concludes that parameters such as body condition score, parity and calving season had an influence on several of the metabolic factors measured in this experiment.

23 Effects of chop length of alfalfa and corn silage on milk production and rumen fermentation of dairy cows

Journal of Dairy Science, May 2007, Volume 90, Number 5, pages 2355-2366.

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The purpose of this study was to evaluate the impact on milk production and rumen fermentation of dairy cows fed alfalfa silage and corn silage cut at two different lengths. Researchers used 16 midlactating Holstein cows during periods of 21 days: 14 days for adaptation to the diet, followed by 7 days for sampling. Corn and alfalfa silage were cut at 10 mm (short) and 19 mm (long). The total mixed ration consisted of 44 % barley grain, 12.6 % protein supplement, 21.7 % alfalfa silage (short or long) and 21.7 % corn silage (short or long). It was found that feeding short silage resulted in shorter average geometric particle length, both in alfalfa (14.4 to 11.0 millimeters) and corn (14.2 to 10.4 millimeters). For alfalfa only, short silage resulted in an increase of feed intake, milk yield and rumen volatile fatty acids between 4 and 5 hours after feeding, but did not affect rumen acidity (pH). For corn only, short silage resulted in an increase of feed intake, and in rumen acidity between 4 and 5 hours after feeding (from 6.12 to 6.20) but did not affect rumen volatile fatty acids. Over the duration of the experiment, daily milk production averaged 38.2 kilograms per day, milk fat percentage averaged 2.62 % and milk protein percentage 3.29 %, independently of the diets. The study concludes that pH results from this experiment must be interpreted with caution, as it was found that subacute ruminal acidosis may have been induced because of lower than recommended content of forage neutral detergent fiber for barley grain diets.

24 Fatty acid composition of ruminal bacteria and protozoa, with emphasis on conjugated linoleic acid, vaccenic acid, and odd-chain and branched-chain fatty acids

Journal of Animal Science, May 2007, Volume 85, Number 5, pages 1228-1234.

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Since the main point of interest in raising ruminants such as cattle is the transformation of feed (grain, silage) into products such as milk or meat, a better understanding of rumen micro organisms can help to improve both productivity and animal health. The objective of this study was to characterize the fatty acid profiles of mixed rumen bacteria and protozoa, and in particular to measure the content of conjugated linoleic acid, vaccenic acid, odd-chain and branched chain fatty acids. For the purpose of the experiment, rumen contents were centrifuged to isolate bacteria and protozoa. In both protozoal and bacterial portions, the main fatty acids were stearic (18:0) and palmitic (16:0). Researchers found 74% more palmitic acid in the fatty acids from protozoa compared to fatty acids from bacteria. However, they also found that bacteria contained 225% more stearic acid compared to protozoa. Bacterial fatty acids had 16.5% of total odd-chain and branched-chain fatty acids, whereas that proportion was 11.0% for protozoal fatty acids. As for anteiso-17:0, the content was 1.4 % in bacterial fatty acids and 2.9 % in protozoal fatty acids. Vaccenic acid (18:1 trans-11) was measured at 6.6% of total protozoal fatty acids and at 2.0% of total bacterial fatty acids. Finally, protozoal fatty acids contained 8.6 times more cis-9 trans11 conjugated linoleic acid (1.32 %) than bacterial fatty acids (0.15%). The study concludes that production of conjugated linoleic acid and other unsaturated fatty acids for lower guts absorption may be increased by the presence of protozoa in the rumen.

25 High grain diets perturb rumen and plasma metabolites and induce inflammatory responses in early lactation dairy cows

Italian Journal of Animal Science, 2007, Volume 6, Supplement 1, pages 424-426.

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The objective of this study was to evaluate the effect of different barley grain diets on ruminal fluid, plasma metabolites, and plasma acute phase proteins. For this experiment, researchers used 8 rumen cannulated Holstein dairy cows and fed them with total mixed ration containing 0, 15, 30 and 45 % barley grain, barley silage and 15% of concentrate mix. The length of each period of experiment was 21 days: 11 days for adaptation to the diet, followed by 10 days of sampling and measurements. Mineral and vitamin mixes, and isoenergetic and isonitrogenous diets were given in the same quantity to cows of all groups. Samples of blood and rumen fluid were collected in the measurement period, on days number 1, 3, 5, 7 and 10, before the morning meal. It was found that an increase of barley grain in the diet resulted in an increase of endotoxin in ruminal fluid. Cows who had the 45% barley grain diet had the highest amount of endotoxin in their rumen (8,869 nanograms per milliliter) while cows that were given the diet containing no barley grains (control group) had the lowest quantity of endotoxin their rumen (654 nanograms per milliliter). Cow at 15 % and 30 % barley grain diets had 791 and 5,021 nanograms per milliliter of endotoxin in their rumen respectively. As for ruminal acidity (pH), researchers found that the group of cows with the 45% barley grain diet had the lowest pH at 6.5 while the control group had the highest pH level at 6.8. Overall, the study concludes that an increase in feeding barley grains results in an increase of rumen acidity (decrease of rumen pH), increased amount of endotoxin in rumen fluids, and increased amount of plasma acute phase proteins.

26 Altering physically effective fiber intake through forage proportion and particle length: Chewing and ruminal pH

Journal of Dairy Science, June 2007, Volume 90, Number 6, pages 2826-2838.

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The main objective of this study was to assess the risk of ruminal acidosis in dairy cows based on the content of physically effective neutral detergent fiber in the diet. Researchers used 8 ruminally cannulated lactating dairy cows for this experiment. The diets consisted of short and long alfalfa silages mixed with low (35:65) and high (60:40) forage:concentrate ratio (dry matter basis). It was found that increasing the forage:concentrate ratio and forage particle length resulted in an increase of average ruminal pH (lower pH indicates the rumen is more acidic, which is undesirable) level by 0.5 and 0.2 units respectively. When cows were fed the low forage:concentrate diet, their ruminal pH stayed below 5.8 for over 10 hours/day, and below 5.5 for over 7 hours daily whereas cows eating the high forage:concentrate diet had a ruminal pH below 5.8 for only 1.2 hours/day and below 5.5 for only 0.1 hours/day. As for volatile fatty acids, an increase of forage: concentrate ratio resulted in a decrease of the concentration but it also increased the acetate:propionate ratio from 1.82 to 3.13. There was a direct positive correlation between the amount of physically effective neutral detergent fiber and chewing time and mean ruminal pH. The more physically effective neutral detergent fiber the cows consumed, the more they ruminated and the less they experienced ruminal acidosis. This study concludes that the risk of ruminal acidosis is higher when cows are fed a diet having a low forage:concentrate ratio. This is especially true when the silage is finely chopped. Ruminal acidosis can be prevented by increasing the proportion of forage in the diet as it will increase chewing time and reduce the intake of starch, which is rapidly digested in the rumen. Increasing forage particle length also elevates ruminal pH, but in low-forage diets it does not completely alleviate ruminal acidosis because the fermentability of the diet is high and changes in chewing activity are marginal.

27 Enhancing *in vitro* degradation of alfalfa hay and corn silage using feed enzymes

Journal of Dairy Science, June 2007, Volume 90, Number 6, pages 2839-2851.

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The purpose of this study was to assess the potential effects of 4 feed enzymes on the ruminal digestion of alfalfa hay and corn silage in vitro. The four enzyme products, which included a variety of carbohydrate-digestig enzymes (endoglucanases, exoglucanases and xylanases) and protease activities, were tested in fermentation experiments over a range of dose rates. Researchers found that, for alfalfa hay, all four enzyme products generated a quadratic increase of gas production and digestion of dry matter. Low and medium doses showed to be the most efficient. The action of enzymes on corn silage was quite different as none of them increased gas production or dry matter digestion. However, all 4 enzyme products increased neutral detergent fiber digestion with the most efficient response at low to medium dose rates. The action of the proteolytic enzyme papain on fiber digestion for alfalfa and corn silage was found to be similar to the action of the carbohydrate-digesting enzymes. For the carbohydrate-digesting enzymes, it was possible to increase neutral detergent fiber digestion of corn silage by adding endoglucanases and exoglucanases. For alfalfa, only endoglucanases improved fiber digestion. Neutral fiber digestion of corn silage was further improved when scientists blended carbohydrate and protein digesting enzymes. However, that improvement was not observed for alfalfa hay. Researchers also found that combining two or more enzymes generally improved the performance of fiber digestion to an extent equal to the sum of the enzymes' individual effects. Overall, increasing of fiber digestion using enzymes decreased the ratio of acetate:propionate. The study concluded that milk production of dairy cows may possibly be improved by using enzymes that have good performance for digesting forages *in vitro*.

28 Effect of grains differing in expected ruminal fermentability on the productivity of lactating dairy cows

Journal of Dairy Science, June 2007, Volume 90, Number 6, pages 2852-2859.

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The purpose of this experiment was to assess the effect of feeding barley and corn grains on dry matter intake and milk production of lactating dairy cows. In this experiment, researchers used 22 multiparous and 9 primiparous lactating Holstein dairy cows. The cows were fed with experimental diets consisting of one of the following: 1) steam-rolled barley Dillon, 2) steam-rolled barley Xena, and 3) a mixture of about 87.5% dry ground corn, 11.4% beet pulp and 1.1% urea. Previous measurements of starch digestibility made in vitro during 6 hours for Dillon, Xena and corn mixtures were 73.5 78.0 and 71.0 %, respectively and starch content was 50.0, 58.7 and 60.4%, respectively. It was found that, compared to cows eating barley, those eating corn grain had higher dry matter intake (23.6 vs. 21.6 kilograms per day), milk production (40.4 vs. 37.4 kilograms per day), milk protein (1.20 vs. 1.12 kilograms per day) and milk lactose (1.85 vs. 1.74 kilograms per day). Regarding the two cultivars used in this experiment, their effect was similar on dry matter intake, but compared to cultivar Dillon, cows fed the Xena produced more milk (38.5 vs. 36.2 kilograms per day), milk protein (1.18 vs. 1.07 kilogram per day) and milk lactose (1.80 vs. 1.69 kilograms per day). However, milk fat concentration was higher when cows were fed with Dillon compared with Xena (3.47 vs. 3.23 %). The study concludes that milk production of lactating dairy cows may not be increased by a reduction of ruminal starch digestion of barley grain.

29 Selection of barley grain affects ruminal fermentation, starch digestibility, and productivity of lactating dairy cows

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The purpose of this study was to assess the effects of 2 types of barley grain cultivars on dry matter intake, ruminal fermentation, ruminal and total tract digestibility, and milk yield of dairy cows, knowing that those two types of grain have different rates of ruminal starch digestion. For this experiment, researchers used four primiparous ruminally cannulated plus four multiparous ruminally and duodenally cannulated dairy cows. The diets evaluated 2 types of barley grain cultivars (Dillon and Xena) at two different starch concentrations (30 vs. 23 % of dry matter). Compared to the Dillon cultivar, Xena had a higher quantity of starch (58.7 vs. 50.0 %) and a higher 6-h in vitro starch digestibility (78.0 vs. 73.5 %). Both diets were prepared to provide equal amounts of crude protein (18.3 %) and forage neutral detergent fiber (20.0 %). It was found that the diets did not affect dry matter intake or milk production. However, compared to the Xena cultivar, cows fed the Dillon had generated a higher milk fat content (3.55 % vs. 3.29 %). High-starch diets resulted in greater ruminal starch digestion compared to low-starch diets (4.55 vs. 2.49 kilograms per day). The same benefit was observed when Xena was used compared to the Dillon cultivar (3.85 vs. 3.19 kilograms per day). Xena also lowered ruminal acetate and increased propionate concentration compared to the effects observed with the Dillon cultivar. Another important effect of the Xena cultivar on ruminal activity was the increased time spent below pH 5.8 (6.6 vs. 4.0 hours per day) and the increased total tract starch digestibility (94.3 vs. 93.0 %) compared to cows fed with Dillon. High-starch diets also increased time spent below pH 5.8 (6.4 vs. 4.2 hours per day) and total tract starch digestibility (94.3 vs. 93.0 %). The study concluded that rumen fermentation and milk fat production can be affected by the choice of barley grains and this change can be as important as a change in dietary starch concentration.

30 Effects of the method of conservation of timothy on nitrogen metabolism in lactating dairy cows

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The purpose of this study was to assess the effects of feeding timothy (in hay form or as a restrictively or extensively fermented silage) on a series of parameters: ruminal metabolism, microbial protein synthesis, nitrogen utilization, Leu kinetics, intestinal flow of nutrients, and milk yield in lactating dairy cows. Researchers used 6 ruminally and duodenally cannulated primiparous Holstein dairy cows. Diets were formulated to contain 44 % (dry matter basis) of a common concentrate mixed with timothy in one of 3 different forms: hay, restrictively fermented silage, or extensively fermented silage (with crude protein contents of 10.4, 13.6 and 14.8 % respectively). When timothy was fed in the form of hay or restrictively fermented silage, cows transformed feed nitrogen into milk nitrogen more efficiently. Treatments had no effects on apparent intestinal digestion of essential amino acids and on microbial protein synthesis, even if nitrogen intake was lower (14 %) when cows were fed timothy hay. Haying decreased feed protein degradation in the rumen whereas restricting silage fermentation had no effect. A ruminal lipogenic fermentation was induced (acetate:propionate ratios of 4.55, 4.23 and 3.78 for hay, restrictively fermented and extensively fermented silage, respectively) when timothy was fed in the form of hay or restrictively fermented silage. No changes were induced to milk fat production and plasma glucose. Overall, the treatments had no effect on body protein metabolism.

31 Production performance and milk composition of dairy cows fed whole or ground flaxseed with or without monensin

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The objective of this experiment was to assess the effects of flaxseed (with or without monensin) on feed intake, digestion, blood composition, milk yield and composition, and milk fatty acid. Researchers used 8 multiparous Holstein dairy cows (averaging 60 ± 20 days in milk) and fed them with ground or whole flaxseed (with or without monensin added at 0.02 % in dry matter) during 4 periods of 21 days. The treatments produced no change in feed intake of dry matter. Compared to cows that had ground flaxseed, those who received whole flaxseed presented higher digestibility of acid detergent fiber and lower digestibility of crude protein and ether extract. There was no effect of monensin on digestibility. Ground flaxseed resulted in higher milk production compared to whole flaxseed (22.8 vs. 21.4 kilograms per day respectively). Milk production was not affected by adding monensin to the diet; however, monensin decreased fat-corrected milk production by 4 % because of a decrease in the quantity of milk fat. The amount of 16:0, 17:0 and cis6-20:4 fatty acids decreased in milk fat while cis6-18:2, cis9, trans11-18:2 and cis3-18:3 increased when the cows were fed with ground flaxseed, compared to whole flaxseed. The effect of monensin on fatty acids of milk fat was an increase of cis9 and trans11-18:2, and a decrease of saturated fatty acids. Ground flaxseed and monensin interacted, providing a higher quantity of trans11-18:1 in milk fat compared to the other feed mixes. The study concluded that fatty acid composition of milk fat was successfully changed with ground flaxseed and monensin that might favour nutritional value for consumers.

32 Short communication: Absorption of 2-hydroxy-4-methylthiobutanoate in dairy cows

Journal of Dairy Science, June 2007, Volume 90, Number 6, pages 2937-2940.

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The purpose of this experiment was to assess the net portal absorption of 2-hydroxy-4-methylthiobutanoate (HMTBA) in dairy cows. Researchers used four multicatheterized lactating dairy cows over 7-day periods. Every two hours, the cows were fed with a mixed ration and received a supplement (12.5 to 25 grams per meal) of HMTBA twice a day. It was found that net portal absorption of HMTBA was higher in the cows who received the 25 grams doses, compared to those who had 12.5 grams per meal, but when related to the dose given, the quantity relative to the dose was quite constant: overall, 11.2 % of HMTBA ingested (at both doses of 25 and 12.5 grams per meal) reached the portal circulation when cows were fed 12 times daily. After HMTBA used by the gut is added to the calculation (based on previous finding of 5 % with sheep), total availability increases to 16.5 % of the quantity ingested. Researchers presented a method based on circulating concentrations of HMTBA to estimate simply the net portal absorption of HTMBA. The concordance between estimations and direct measurement was high (97 %) and validated the possibility of using this simplified procedure whenever it is necessary to assess HTMBA absorption in various feeding scenarios. The study concludes that estimating HTMBA absorption based on circulating concentrations is a simple and effective means to establish the different factors affecting HMTBA in dairy cows.

33 Use of an *in vitro* fermentation bioassay to evaluate improvements in degradation of alfalfa hay due to exogenous feed enzymes

Animal Feed Science and Technology, June 2007, Volume 135, Number 3-4, pages 315-328.

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The objective of this study was to evaluate the performance of five developmental enzyme products on the digestion of alfalfa during *in vitro* experiments. The first 2 enzyme products were proteases (protein-digesting enzymes) and the other 3 were fiber-digesting enzymes with different combinations of cellulases (endoglucanases) and hemicellulases (xylanases). The enzyme were put in an incubator with alfalfa hay products (1.5 milligrams per gram of forage dry matter), ruminal fluid and a buffer. After 12, 18 and 24 hours of incubation, gas production and fibre digestion were measured and recorded. It was found that protease enzyme # 1 increased gas production at all incubation times by 5.6 to 7.9%. Protease enzyme # 2 had no effect on gas production. As for the fiber-digesting enzymes, use of enzyme # 1 and # 2 resulted in an increase of gas production ranging from 3.7 to 10.6% over the 3 incubation times (12, 18 and 24 hours), whereas use of enzyme # 3 resulted in no effect. Similarly, for neutral detergent fibre, fiber-digesting enzymes # 1 and # 2 increased digestion by 10 to 16.5%, depending upon the incubation time. All 3 fiber-digesting enzyme products resulted in a decrease in the acetate-propionate ratio. Overall, protease enzyme # 1 and fiber-digesting enzyme products # 1 and 2 were considered effective feed enzymes for ruminants as detected by sizable increases in gas production and dry matter digestion at all incubation times, increases in fibre digestion at 18 or 24 hours of incubation, and beneficial changes in volatile fatty acid composition. The increased fiber digestibility due to f proteolytic and fibrolytic enzymes in the current study would be expected to increase milk production and improve nutrient utilization of dairy cows. The study concluded that *in vitro* methods can be useful in assessing the performance of enzymes for ruminants.

34 Calculations of apparent ruminal synthesis and intestinal absorption of biotin in dairy cows as influenced by the extraction method

Archives of Animal Nutrition, 2007, Volume 61, Number 3, pages 157-167.

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Biotin is an important B-complex vitamin present in 2 forms in nature (free vitamin or bound to proteins), and whose activity influences gluconeogenesis, fatty acid biosynthesis, and amino acid catabolism. In recent scientific studies (1998 to 2004), biotin has been linked to increased milk production and metabolic improvements in dairy cows when this particular vitamin was provided as a supplement to their diet. One likely reason for this is the possibility that ruminal synthesis does not provide enough biotin to fulfill the needs of the cow and rumen microbes. Biotin present in plants is degraded during digestion and produces biocytin, a compound that can only be degraded by the action of biotinidase (an enzyme present in pancreatic secretions and intestinal mucosa). This enzyme is not included in analytical assays generally used. A method for sample preparation using biotinidase was developed before analysis by ELISA. The objective of this study was to compare the effect of this new method with several preparation methods currently used on biotin concentrations, both in feed and intestinal digesta of dairy cows and the consequences of these differences on calculations of apparent ruminal synthesis and intestinal absorption. Researchers used 3 duodenally and ileally cannulated dairy cows in this experiment. Findings demonstrated that extraction techniques currently used to determine biotin concentrations in complex matrices as feed and intestinal digesta samples do not account for total biotin. When measuring either free or total biotin concentrations, no ruminal synthesis was observed. It was also found that biocytin present in the feed cannot be degraded or used by rumen microbes but was released in the small intestine under the action of biotinidase present in pancreatic secretions and intestinal mucosa. Therefore, the study concluded that biotin synthesis in the small intestine as reported in the literature is an artefact due to the fact that previous methods only measured free biotin. When a method accounting for total biotin is used, it appears that substantial absorption of biotin from feeds takes place in the small intestine.

35 Repeated ruminal dosing of *Ruminococcus flavefaciens* NJ along with a probiotic mixture in forage or concentrate-fed dairy cows: Effect on ruminal fermentation, cellulolytic populations and *in sacco* digestibility

Canadian Journal of Animal Science, June 2007, Volume 87, Number 2, pages 237-249.

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Scientists have tried numerous times to introduce microbes from other animals (exogenous microbes) in the rumen of dairy cows in order to improve ruminal performance. The experiments have shown that the half-life of exogenous bacteria in the cow's rumen ranges from 30 minutes to 30 days. The objective of this study was to evaluate the effects of introducing a highly fibrolytic bacteria in the rumen of dairy cows and young calves, hoping to see the bacteria survive and grow in these new environments. Researchers used 6 ruminally fistulated non-lactating dairy cows receiving a diet of high or low concentrate forage and a supplement of probiotic on a daily basis. Exogenous bacteria (*Ruminococcus flavefaciens* NJ), taken in the rumen of a wild moose, were then introduced in the rumen of the cows. A second experiment was set to provide the *Ruminococcus flavefaciens* bacteria and probiotic mixture to young calves aged from 21 to 35 days. It was found that, compared to no dosing, the bacteria had an effect on the concentration of other cellulolytic bacteria, and increased *in sacco* digestibility of timothy hay when the cows were fed with the high concentrate diet. The Ruminococcus flavefaciens NJ bacteria concentration decreased rapidly in the cows' rumen from 10^6 mL-1 at dosing time to 102 cells mL-1 after 24 hours. Over the weeks, there was an increase in the lifetime of the bacteria (count of 10^5 cells mL-1 at 48 hours after dosing) or when it was inoculated in the rumen of young calves (10^2 cells mL-1 at 7 days after dosing). Neither probiotics nor other forage:concentrate ratios resulted in a new strain of bacteria in the cows' rumen.

36 Meeting water requirements of cattle on the Canadian prairies

Rangeland Journal, June 2007, Volume 29, Number 1, pages 79-86.

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It is well known that water is the most important element for the well being of any animal. It is especially an absolute necessity for the good operation of the whole digestive tract, from food intake to excretion of waste. When they lack quality water, animals become ill and die more rapidly than when they lack any other nutrient. For cattle, the main factors having an impact on their water requirement are environmental temperature, the health status of animals, the amount of dry matter in the diet, the quantity of water in the feed given to the cattle, and special lactation needs. This study looks at the particular issues that farm owners of the Canadian prairies must face to meet their livestock water requirements. The prairies are a semi-arid region where water is supplied mostly from ground and surface sources. Some of the main problems that must be addressed by farmers living in these regions are the quality of water stored in reservoirs made of earth, and the possible presence of sulfates and toxins such as cyanobacteria in water. Also, cattle activities such as grazing near sources of water such as rivers and lakes have an impact on fish habitat, stream morphology, vegetation growing on the banks, and overall pollution of water. In many cases, the damage is caused by a lack of control in the manner and time spent by cattle grazing along those waters. Water quality and drinkability is also affected by various chemical and biological elements. Diminishing water supply in the Canadian prairies may lead to competition in the future. The article concludes that strategies will need to be discussed and developed in order to resolve these issues.

37 Altering physically effective fiber intake through forage proportion and particle length: Digestion and milk production

Journal of Dairy Science, July 2007, Volume 90, Number 7, pages 3410-3421.

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The objective of this study was to assess the effects increasing the physically effective neutral detergent fiber intake of cows by either increasing the forage: concentrate ratio or by increasing the particle length of the forage. The study measured milk production and composition, and microbial protein synthesis in the rumen of lactating dairy cows. Researchers used 12 lactating dairy cows in this experiment; 4 were not cannulated, 4 were ruminally cannulated and the last 4 were ruminally and duodenally cannulated. The cows were fed with diets consisting of alfalfa silage of two different particle lengths (short and long) mixed at two different forage:concentrate ratios; low (35:65) and high (60:40) (dry matter basis). Researchers observed that an increase in the forage:concentrate ratio resulted in a 9% decrease in dry matter and a 46% decrease in starch intake. However, it also increased fiber intake form forages by 53%. No effect was detected on digestibility of dry matter in the whole tract, but an increase of the forage:concentrate ratio improved the total digestion of fiber and nitrogen. Milk production decreased while yield of 4% fat-corrected milk was the same between the two forage:concentrate diets as a result of increased fat content. An increase of forage particle length resulted in an increase intake of physically effective neutral detergent fiber, in particular when the cows were fed with the diet having a high forage:concentrate ratio. The study concluded that, because physically effective neutral detergent fiber has a positive impact on rumen performance, fiber digestion is improved when the quantity of neutral detergent fiber is increased, either by augmenting the proportion of forage in the diet or by providing forage with longer particle length.

38 Effects of dietary supplements of folic acid and vitamin B on metabolism of dairy cows in early lactation

Journal of Dairy Science, July 2007, Volume 90, Number 7, pages 3442-3455.

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The objective of this research was to study the effects of vitamin B_{12} and folic acid on milk production and metabolism of multiparous dairy cows in early lactation. Researchers used 24 multiparous Holstein cows and gave them dietary supplements of folic acid (0 or 2.6 grams per day) and vitamin B_{12} (0 or 0.5 grams per day) over a period starting 3 weeks before and ending 8 weeks after calving. It was found that folic acid, given alone or in combination with vitamin B_{12}, increased milk production (from an average of 38.0 to 41.4 kilograms per day) and milk crude protein yield (from an average of 1.17 to 1.25 kilograms per day). In cows fed folic acid supplements, supplementary B12 increased plasma glucose. There was no treatment effect on plasma nonesterified fatty acids. However, ingestion of folic acid supplements by cows fed no supplementary B_{12} increased total lipid and triacylglycerols in liver, whereas these supplements had no effect in cows supplemented with B_{12}. The increases in milk and milk protein yields due to folic acid supplements did not seem to be dependent on the vitamin B_{12} supply. However, when vitamin B_{12} was given in combination with folic acid, utilization of the two vitamins seems to be increased, probably more so in extrahepatic tissues. Moreover, when folic acid was given in combination with vitamin B_{12}, metabolic efficiency was improved, as suggested by similar lactational performance and dry matter intake than cows fed folic acid supplements alone, but increased plasma glucose and decreased concentrations of lipids in liver.

39 A mathematical approach to predicting biological values from ruminal pH measurements

Journal of Dairy Science, August 2007, Volume 90, Number 8, pages 3777-3785.

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Measurement of pH acidity (pH) using continuous recording equipment is becoming a more common practice by scientists because it automatically provides a large quantity and variety of data over a long period of time : information such as maximum pH, minimum pH, mean pH, amount of time passed below pH 5.6 and 6.0 (in minutes per day), etc. However, continuous recording is also considered by many to be a complicated and costly technique. This is why researchers have developed a new method for assessing ruminal acidity (pH). The study had four objectives: 1) to collect data from previous experiments on ruminal acidity when pH data was recorded continuously, 2) to analyze the data and develop a set of mathematical equations, 3) to select the equation that best represents the data, 4) to develop values from equations that may help to understand the biological aspect of dietary treatments. From several previous experiments, researchers used 613 records and used them in a global analysis. It was found that diets having a higher level of non fiber carbohydrates had the strongest lowering effect on ruminal pH. From this experiment, scientists suggest to summarize continuously recorded pH data with model-derived biological indications developed in this experiment. The study concluded that the mathematical method developed here can help to assess the effects of diets on ruminal pH and makes possible a comparison of pH data from different studies.

40 Evaluating the conjugated linoleic acid and trans 18:1 isomers in milk fat of dairy cows fed increasing amounts of sunflower oil and a constant level of fish oil

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There is an increasing demand from the public for value-added foods, including dairy products, to help improve the health condition of the population. The objective of this experiment was to assess the effects of various levels of sunflower oil in dairy cows' diets in order to increase vaccenic and rumenic acids in milk fat, and also evaluate the quantity and composition of trans-octadecenoic and conjugated linoleic acids isomers. Researchers used 80 lactating Holstein dairy cows for this experiment. First, the cows were fed with a control diet during 4 weeks and then, they received 4 treatment diets for a total of 38 days. Diet # 1 was the control diet (barley/alfalfa/hay silage and corn/barley concentrate with a 50:50 forage:concentrate ratio), diet # 2 included 1.5 % of sunflower oil and 0.5 % of fish oil in the ration, diet # 3 contained 3 % sunflower oil and 0.5 % fish oil added, and diet # 4 was supplemented with 4.5 % sunflower oil and 0.5 % fish oil in the ration. None of the diets increased milk production, milk protein or lactose. The combination of sunflower oil and fish oil, however, reduced milk fat compared to levels of pre-treatment periods. Short and medium-chain saturated fatty acids in milk fat decreased in a linear manner after 10 days while a corresponding linear increase was observed for total *trans*-18:1 and total conjugated linoleic acids. A desirable milk fat containing 4% vaccenic and 2% rumenic acids was achieved by feeding moderate amounts of sunflower oil 3% sunflower oil in the presence of 0.5% fish oil.

41 Use of flavored drinking water in calves and lactating dairy cattle

Journal of Dairy Science, August 2007, Volume 90, Number 8, pages 3831-3837.

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Dairy cows have a well developed sense of taste and this particularity has not been studied as much as some other points of interest such as the nutrient content of feed, although a few studies have been conducted in the past on the addition of flavors to the feed. However, this practice resulted in a production of secondary flavors since natural food already has its own flavor. It might be better to add flavor to something that has no flavor, like drinking water. The objective of this study was to evaluate the effect of adding flavor to drinking water of Holstein calves and lactating dairy cows, and to assess the impact on dry matter intake. In the first experiment, researchers used 9 calves and provided them with natural water or water flavored with orange or vanilla. All the calves received a commercial starter formula. Compared to the control and vanilla treatments, calves drinking the water flavored with orange had a higher dry feed intake (starter). This resulted in a higher body weight gain for those calves. A second experiment was conducted with 4 second-lactation dairy cows. They were given unflavored water or another orange flavored water in a setting of free access and time-restricted access to water. This second experiment did not produce any significant change in dry matter intake, water ingestion or milk production. Over time, cows seemed to increasingly prefer unflavored water. Overall, the experiment was successful for young calves and the use of orange flavor in the drinking water of those animals is an interesting option to increase their feed intake and body weight.

42 Effect of glutamine supplementation on splanchnic metabolism in lactating dairy cows

Journal of Dairy Science, September 2007, Volume 90, Number 9, pages 4325-4333.

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Glutamine is an abundant amino acid, considered to be nonessential since it is produced naturally in mammalian tissues. However, under certain demanding conditions such as infection or recovering from a surgery, glutamine supplementation has resulted in some beneficial outcomes. The objective of this study was to assess the effects of supplying glutamine to early lactation dairy cows on milk yield and composition, and on the net flux of glutamine and other energetic nutrients across the splanchnic (gut plus liver) and mammary beds. Researchers used 7 multiparous dairy cows and gave them abomasal solutions (to by-pass the rumen) of water or 300 grams per day of glutamine during a period of 21 days. Adding glutamine resulted in an increase of milk production (3 % more). However, the 2.4 % increase in milk protein was not considered statistically significant. Portal and hepatic blood flows were not affected by glutamine. An increase of 43 % in plasma glutamine concentration resulted from the glutamine treatment but no effects were observed for splanchnic flux of amino acids (essential or nonessential). Supplementing glutamine to the cows resulted in an increase of plasma urea nitrogen concentration related to a tendency of glutamine to increase hepatic urea flux. The glutamine additive did not affect mammary uptake of glucose and amino acids (this included glutamine). No effects of glutamine were observed on glucose metabolism (plasma concentration, net liver release, net portal appearance, post-liver supply). This study concluded that supplemental glutamine given in postruminal infusions did not result in a decrease of glucose consumption across the gut, or an increase in liver gluconeogenesis, or an increase of mammary absorption of glutamine.

43 Effects of barley grain processing on productivity of cattle

Animal Feed Science and Technology, September 2007, Volume 137, Number 1-2, pages 1-24.

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The objective of this study was to conduct a literature review on the impact of processing of barley grain (chemical, physical, enzymatic) on the productivity of lactating dairy cows and beef cattle. A second objective was to assess how the animals react to barley grain processing. Barley grain is used extensively in the feed of dairy and beef cattle. The grain kernel is protected by a natural envelope called the pericarp, and this makes barley a difficult grain to digest as is. This is why barley grain must be processed mechanically with dry rolling to break the pericarp envelope and crush the grain. However, dry rolling also shatters the grain kernels so other processing methods may be used like steam rolling or temper rolling. Grains may be chemically treated with sodium hydroxide to improve ruminal starch digestibility. Other treatments such as roasting and aldehyde optimize organic matter degradation in the rumen by slowing the degradation rate of crude protein. On the contrary, treating barley grain with ammonia or fibrolytic enzymes increases the digestion process. The consistency of particle size is an important factor to take into account when processing grain. Overall, the dietary value of barley grain is the result of several factors such as initial grain quality, selection of processing method, extent of processing, and the interactions between these factors. The study concluded that more research is needed to support the development of an integrated quality parameter accounting for physical, chemical and biochemical characteristics of processed barley grain.

44 Effects of potential dietary antiprotozoal supplements on rumen fermentation and digestibility in heifers

Animal Feed Science and Technology, September 2007, Volume 137, Number 1-2, pages 126-137.

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The objective of this study was to assess the effects of feeding supplements containing high levels of tannin, saponin and linoleic acid on the eradication of ruminal protozoa in Jersey heifers. Researchers used 4 duodenally cannulated Jersey heifers and fed them with 4 different diets: 1) a control diet made of rolled barley grain and barley silage, 2) a quebracho diet consisting of the control diet with 6 grams of quebracho (source of tannin) per kilogram of dry matter, 3) a quillaja diet consisting of the control diet with 8 grams of quillaja extract (source of saponin) per kilogram of dry matter, 4) a safflower diet consisting of the control diet with 27 grams of safflower oil (source of linoleic acid) per kilogram of dry matter. The Jersey heifers were fed with those rations during 4 periods of 47 days. It was found that, compared to the control diet, supplementing safflower caused a more important reduction of protozoa than the diets with quebracho or quillaja supplements. None of the treatments affected the concentrations of ruminal ammonia and volatile fatty acids. Also, they did not affect cellulolytic, deaminative and amylolytic enzyme activities. No changes were observed on the flow of non-ammonia nitrogen or bacterial nitrogen to the duodenum, or on the digestibility. The study concluded that the supplements decreased the quantity of protozoa in ruminal fluid, but the decrease is not enough to have a significant effect on the predation of bacteria. It would be difficult to supplement higher doses of these supplements without producing undesirable effects on feed intake or digestibility.

45 Rumen degradation ratios, available protein, and structural and non-structural carbohydrates: Comparison of frost-damaged wheat with normal wheat

Canadian Journal of Animal Science, September 2007, Volume 87, Number 3, pages 449-454.

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Wheat may be affected from time to time by exceptional meteorological conditions such as early frost. In theses cases, the cereal becomes unsuitable for human consumption but it may still be used for feeding animals such as dairy cattle. However, little is known about the degradation and fermentation properties of wheat after an alteration by frost. The objectives of this project were to assess rumen decomposition properties and ratios of frost-damaged wheat in relation to crude protein, structural carbohydrates, and non-structural carbohydrates (starch). Researchers used 2 ruminally cannulated Holstein-Friesian dairy cows and fed the animals with normal wheat and wheat damaged by frost. The damaged wheat was divided in 3 categories: Damaged (less than 10 % of weight loss), Highly Damaged (10 % or more but less than 20 % of weight loss), and Severely Damaged (20 % and more of weight loss). The ratio between total insoluble Nitrogen and insoluble carbohydrates was found to be very much different for damaged wheat compared to normal wheat, but ratios between total available Nitrogen and total available carbohydrates, and between total soluble Nitrogen and soluble carbohydrates were similar. The study concluded that, even though there is a difference between the decomposition characteristics of normal and frost-damaged wheat, both cereals had an optimum level of rumen fermentation.

46 Duration of a severe feed restriction required to reversibly decrease milk production in the high-producing dairy cow

Canadian Journal of Animal Science, September 2007, Volume 87, Number 3, pages 455-458.

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The objectives of this project were 1) to develop a model of restrictive diet for early lactation, high producing dairy cows that would result in a decrease of milk production by at least 30 % without affecting future milk production and without inducing clinical ketosis, and 2) to characterize the changes induced by the restricted diet on hormone and plasma nutrient levels. Researchers worked with 3 Holstein cows in 3rd lactation (approximately 45 days in milk), housed in tie-stalls. The animals had a restricted access to feed during 24 hours, after which period they were fed normally again with the total mixed ration. Water was freely available at all times. From 10 days before the experiment to 10 days after, milk production was recorded. During the experiment, the cows were milked every 6 hours and samples of blood, urine and milk were collected at the same time. Fresh urine samples were tested for ketone bodies. Other testing was also conducted on glucagon, insulin, and plasma cortisol. A rise in ketone bodies was observed (even after refeeding the animals), indicating that the duration of feed restriction should be determined with caution. It was possible to decrease milk, protein and lactose production by more than 30 % but only after 24 hours of severe feed restriction. The restricted diet did not induce ketosis and did not affect subsequent milk production.

8 Reproduction

1 Trends in growth and age at first calving for Holstein and Ayrshire heifers in Quebec

Canadian Journal of Animal Science, September 2006, Volume 86, Number 3, pages 325-336.

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One important aspect of dairy farming is to make sure new replacement heifers are produced on a regular basis. This process can be expensive; some studies have estimated the cost of raising replacement heifers at 20 % of the total production costs in a typical dairy farm. Reducing the age of the animals at first calving can help to reduce the costs, but heifers need to have a minimum body weight in order to pass the first pregnancy, first calving and first lactation with success. The objective of this project was to conduct a study on heifer growth in the province of Quebec, and link that data with age at first calving. Researchers worked with data from 44,989 Holstein and 2,294 Ayrshire cows, collected from 1993 to 2003. Some of the parameters of interest were: heifer body weights, body condition scores, wither heights, breeding events, first lactation data, and mature body weights. For Holstein heifers, the average age at first calving was found to be 26.5 months, whereas that number was 27.1 months for Ayrshire heifers. Overall, from 1993 to 2003, Holstein and Ayrshire heifers in the province of Quebec calved considerably earlier while having a heavier body weight, compared to heifers from the 1980s. The study concluded that heifer growth may not be a factor preventing a decrease of the average age at first calving.

2 Expressions of cyclooxygenase-II (COX-II) and 20 alpha-hydroxysteroid dehydrogenase (20 alpha-HSD)/ Prostaglandin F-synthase (PGFS) in bovine placentomes: Implications for the initiation of parturition in cattle

Placenta, September-October 2006, Volume 27, Number 9-10, pages 1022-1029.

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The mechanisms leading to luteolysis in preparation for parturition is not fully understood in pregnant cows. However, the hormone named prostaglandin F-2 alpha responsible for luteolysis during the oestrous cycle is a likely candidate. Recently, studies have shown that cyclooxygenase-II and an enzyme called 20 alpha-hydroxysteroid dehydrogenase are most probably causing the production of prostaglandin F-2 alpha. The objective of this project was to study these two chemicals in bovine placentomes. Researchers applied immunohistochemical methods to placentomes of 17 pregnant cows (from day 100 to day 284 in pregnancy), of 3 other cows in the period of progesterone decrease before calving (from day 273 to day 282), and of 5 calving cows. They found cyclooxygenase-II in the animals from day 100 in pregnancy until calving. Between day 100 and 235, the level was moderate and concentrated in specific areas of the placentomes. Using the reverse transcriptase-polymerase chain reaction method in real time, researchers were able to confirm a high level of cyclooxygenase-II production in placentomes, and an increase between 70 and 100 folds (7,000 % and 10,000 %) of the level of cyclooxygenase-II messenger RNA. The study concluded that cyclooxygenase-II and 20 alpha-hydroxysteroid dehydrogenase/PGFS-mRNA may produce prostaglandin F-2 alpha. However, only cyclooxygenase-II has an important effect in the control of a potential placentomal production of luteolytic prostaglandins during the preparturient period.

3 Bovine SNRPN methylation imprint in oocytes and day 17 *in vitro*-produced and somatic cell nuclear transfer embryos

Biology of Reproduction, October 2006, Volume 75, Number 4, pages 531-538.

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Several species (including dogs, cats, sheep, rats, rabbits, horses, pigs and cows) have been successfully cloned using the somatic cell nuclear transfer (SCNT) method. However, the success rate is low and most animals die prematurely before birth or early after birth. Those lucky enough to survive have physiological problems when they grow. There were 2 objectives to this project: 1) to identify in cattle the small nuclear ribonucleoprotein polypeptide N (SNRPN) area that corresponds to the differentially methylated region or DMR of humans and mice in order to verify if the DNA methylation patterns were similar across different species, and 2) to assess how the DNA methylation status of SNRPN in bovine Day 17 embryos is affected by in vitro production and somatic cell nuclear transfer. Using bisulfite sequencing, researchers located a CpG island within the 5' region of SNRPN. Alleles of SNRPN were methylated in oocytes, unmethylated in sperm, and about 50 % of them were methylated in somatic samples. The study concluded that SNRPN DNA methylation patterns found in humans and mice are also present in cattle. Since Day 17 embryos showed an abnormally low level of methylation compared to embryos produced *in vitro* and *in vivo*, somatic cell nuclear transfer is probably responsible for faulty reprogramming or maintenance of methylation imprints at this region.

4 Large-scale transcriptional analysis of bovine embryo biopsies in relation to pregnancy success after transfer to recipients

Physiological Genomics, October 2006, Volume 28, Number 1, pages 84-96.

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Early embryonic mortality has many negative effects on dairy operations: important losses of potential calves, loss of money and time for the producers who must rebreed cows, and a delay in the herds' genetic progress. Most embryo mortality occurs during the 2nd and 3rd week after fertilization. Even though the mechanism leading to embryo mortality is not yet fully understood, scientists believe that defective genes may be responsible ; even one defective single gene may result in pregnancy failure. The objective of this project was to study the gene expression parameters of bovine blastocyst biopsies and their relationship to pregnancy success following transfer to recipients. Researchers have evaluated biopsies from 118 blastocysts (7 days old) produced *in vitro*. The samples represented about 30 to 40 % part of the intact embryo and the rest 60 to 70 % part of the embryo was transferred to recipients after re-expansion. After the normal parturition period, the results were divided in 3 different groups: non-pregnancy, incomplete pregnancy, and calf delivery (successful pregnancy). Researchers found differences in gene types and expressions in each of those 3 groups. The study concluded that blastocyst-specific genes may have an important impact in the success or failure of pregnancy after the embryo is transferred to the recipient.

5 Telophase-stage host ooplasts support complete reprogramming of roscovitine-treated somatic cell nuclei in cattle

Cloning and Stem Cells, Fall 2006, Volume 8, Number 4, pages 305-317.

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The developmental fate of embryos produced by nuclear transfer is greatly dependent of nuclear-cytoplasmic incompatibilities. This is especially true when metaphase arrested oocytes are used as hosts for interphase donor nuclei. The objective of this project was to study the effect of cell cycle coordination on somatic cell cloning. Researchers fused host oocytes before (metaphase II, M-II) or after activation (telophase II, T-II) to somatic cells at different stages of their cell cycle. By treating fetal fibroblast (1717) and granulosa cells with roscovitine, they were able to obtain cells representing different stages of the cell cycle. They observed that, when fused to cells recovered between 16 and 24 hours after passage, embryos reconstructed with T-II cytoplasts showed high rates of blastocyst formation. The other group (M-II) did better with confluent cells. Successful pregnancies and deliveries of healthy calves resulted from the transfer of the blastocysts to heifers. The calves were born from either embryos reconstructed with FF treated with roscovitine and T-II cytoplasts or confluent cells and M-II cytoplasts. The study concluded that M-II and T-II bovine oocytes are equally effective for supporting the reprogramming process of somatic cell nuclei when those oocytes are combined with nuclear donor cells during specific stages of cell cycle.

6 The impact of oocyte maturation media on early bovine embryonic development

Molecular Reproduction and Development, Fall 2006, Volume 73, Number 10, pages 1255-1270.

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Bovine embryos are now routinely produced in laboratory. However, compared to those naturally conceived, they have a higher level of abnormalities. While the exact cause is not known, the culture environment seems to play a major role in the success or failure of the development of oocysts into blastocysts, and eventually into embryos. The objective of this project was to evaluate the impact of oocyte culture media with various protein supplements on the quantity and quality of blastocysts produced in vitro. Researchers collected bovine ovaries at a slaughterhouse in Guelph, Ontario, and brought them to the laboratory. They recovered oocysts by aspiration with a vacuum pump attached to a needle. After analyzing the samples, they found a higher number of cells and a higher ratio of inner cell mass : total cell number (ICM:TCN) in embryos developed from oocysts maturated in Tissue Culture Medium-199 (from a commercial source) and supplemented with serum, compared to blastocysts developed from oocyte maturated in synthetic oviduct fluid supplemented with 8 milligrams per milliliter of Bovine Serum Albumin. Also, oocysts maturated in TCM-199 produced embryos having a higher morphological quality. The study concluded that oocyte culture media has an important impact on the quality of embryos developed in vitro. The authors highlight the need for additional research to better understand occyst maturation mechanisms.

7 Induction of alpha-caveolin-1 (alpha CAV1) expression in bovine granulosa cells in response to an ovulatory dose of human chorionic gonadotropin

Molecular Reproduction and Development, Fall 2006, Volume 73, Number 11, pages 1353-1360.

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Caveolins are intracellular proteins that impact signal transduction, endocytosis and cholesterol trafficking. In a previous experiment, we identified a cDNA (complementary deoxyribonucleic acid) fragment corresponding to bovine caveolin-1. That gene was viewed as being possibly induced in granulosa cells by the luteinizing hormone preovulatory surge. The objective was to clone the full-length bovine caveolin-1 cDNA, and to study the characteristics of caveolin-1 messenger RNA and protein expression in bovine ovulatory follicles. The full-length caveolin-1 cDNA was characterized. Caveolin-1 expression was analyzed from follicles at different stages of development: small (2-4 millimeters), dominant, ovulatory (24 hours after human chorionic gonadotropin injection), and corpus luteum. The level of alpha caveolin-1 messenger RNA was 8.5 times higher 24 hours after the human chorionic gonadotropin treatment. The study concluded that induction of caveolin-1 mRNA and protein in bovine granulosa cells is dependent of the preovulatory luteinizing hormone surge. Because caveolin-1 is able to prevent the action of many intracellular proteins, it is probably an important factor in the control of membrane signalling induced by the preovulatory luteinizing hormone surge at the time of ovulation and luteinization.

8 The influence of follicle size, FSH-enriched maturation medium, and early cleavage on bovine oocyte maternal mRNA levels

Molecular Reproduction and Development, Fall 2006, Volume 73, Number 11, pages 1367-1379.

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The development cycle of oocytes is made of several stages, and many variables are known to have an influence on that development. For example, oocytes matured *in vivo* have better developmental characteristics than oocytes matured *in vitro*. Other factors such as size of the follicle and composition of the *in vitro* maturation media will also have an influence on the development of oocytes. For example, when a follicle-stimulating hormone is added to the maturation media, the quantity of formed blastocysts increases. Several studies have already focused on genes involved in oocyte maturation. However, most of those genes were selected because of their potentiel effects during early development, very few as a result of observations during experimentations with bovine. The objective of this project was to reveal new gene candidates having an effect on the developmental competence of bovine oocytes. Researchers selected 13 gene candidates from a larger library and analyzed them using quantitative polymerase chain reaction (PCR) in order to assess the quantities and levels of oocytes produced from follicles. Results from the analysis showed that gene candidates H2A, CKS1, CCNB2, PTTG1, PSMB2, CDC5L, SKIIP, RGS16 and PRDX1 were significantly correlated with developmental competence, compared to gene candidates CCNB1, BMP15, GDF9, and STK6. The study concluded that highly efficient molecular methods can be used to characterize new variables affecting developmental competence of bovine oocytes.

9 Characterization of bovine early growth response factor-1 and its gonadotropin-dependent regulation in ovarian follicles prior to ovulation

Journal of Molecular Endocrinology, Fall 2006, Volume 37, Number 2, pages 239-250.

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Early growth response factor-1 (EGR-1) is a protein affecting several cellular functions such as differentiation, gene regulation, proliferation, and apoptosis. In animals, most studies of EGR-1 have focused on small rodents so there is a need to investigate the ovarian regulation of EGR-1 in large animals like cows. There were 2 objectives to this project: 1) to evaluate before ovulation the gonadotropin-dependent regulation of cattle EGR-1 in preovulatory follicles, and 2) to analyze the effect of EGR-1 on the activity of genes related to ovulation. Over a period of 24 hours, researchers observed a very low level of EGR-1 messenger RNA in follicles at 0 hours, followed by a sharp increase at 6 hours and a decrease from 12 to 24 hours. The level of EGR-1 messenger RNA was also high in kidney, uterus, corpus luteum, pituitary and spleen, whereas it was low to moderate in other tissues evaluated. Other analyses showed a higher expression of EGR-1 messenger RNA in granulosa cells compared to theca cells. The study concluded that, for the first time, a gonadotropin-dependent induction of follicular EGR-1 was observed before ovulation in large monoovularory animals. The authors also reported the finding of a stimulating effect of EGR-1 on the activity of genes related to ovulation.

10 Characterization of the placenta specific bovine mammalian achaete scute-like homologue 2 (Mash 2) gene

Placenta, November-December 2006, Volume 27, Number 11-12, pages 1124-1131.

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Mash 2 (Mammalian Achaete Scute-like Homologue 2) is a gene having a critical role on the normal development of placenta in mammals such as cattle. Studies conducted with mice have revealed that the gene stimulates cell production and prevents trophoblasts from transforming into giant cells. In bovines, traces of Mash 2 messenger RNA have been found in Day 8 blastocysts but no information exists about their features or about the way they regulate. The objective of this project was to clone and describe the Mash 2 gene in bovines according to imprinting regulation and temporal/spatial behaviour. Cattle used in this experiment were Bos indicus (Nelore) for the paternal genome, and Bos taurus (Holstein) for the maternal genome. Researchers found that bovine Mash 2 messenger RNA is 78 % similar to human Mash 2, and 70 % similar to mouse Mash 2. The bHlH (basic-helix-loop-helix) region shows a very high level of similarity with 95 %, as does the DNA binding domain with 88 %. The largest quantity of Mash 2 messenger RNA was found in Day 17 embryos, when trophoblasts were rapidly spreading. The study concluded that Mash 2 is highly similar from one species to another, and is significantly produced in the bovine placenta. The gene grows in the maternal bovine after implantation, while the regulation process originates from the paternal genome.

11 Control of oestradiol secretion and of cytochrome P450 aromatase messenger robinucleic acid accumulation by FSH involves different intracellular pathways in oestrogenic bovine granulosa cells *in vitro*

Reproduction : The Official Journal of the Society for the Study of Fertility,
December 2006, Volume 132, Number 6, pages 909-917.

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The objective of this research was to identify the main intracellular routes used by follicle-stimulating hormone and insulin to induce Cyp19 gene expression and oestradiol secretion in a model of non-luteinizing bovine granulosa cell culture. Researchers cultured bovine granulosa cells for 6 days. The cells were treated with either insulin (100 nanograms per milliliter) or insulin (10 ng/ml) and follicle-stimulating hormone (1 ng/ml). Researchers observed a significant decrease of insulin-stimulated Cyp19 messenger RNA level and oestradiol concentration when phosphatidylinositol 3-kinase and protein kinase C inhibitors were added to the cultures. The addition of a protein kinase A inhibitor resulted in a significant decrease in the quantity of follicle-stimulating hormone stimulated Cyp19 messenger RNA and secretion of oestradiol. Closing the mitogen-activated protein kinase route resulted in a significant increase of Cyp19 messenger RNA in insulin and follicle-stimulating hormone (FSH) stimulated cells. The study concluded that Cyp19 production is induced by follicle-stimulating hormone mainly through protein kinase A, and secretion of oestradiol is modified by phosphatidylinositol 3-kinase and protein kinase C routes without being affected by the levels of Cyp19 messenger RNA. Furthermore, the authors theorize that Cyp19 is restricted by a mitogen-activated protein kinase route.

12 Prevalence and risk factors for postpartum anovulatory condition in dairy cows

Journal of Dairy Science, January 2007, Volume 90, Number 1, pages 315-324.

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Anovulation is the absence or failure of ovulation. There were two objectives to this project: 1) to determine the prevalence of anovulation in Ontario Dairy Herds, and 2) to identify risk factors associated with the condition. Two milk samples were collected two weeks apart, with the second milk sample collected around 65 days in milk from a total of 1,341 cows from 18 different herds. Anovulation was diagnosed as low circulating progesterone in both samples. A full 20 percent of lactating dairy cows were diagnosed as anestrus at the end of the voluntary waiting period. Within individual herds between 5% and 45% of cows failed to ovulate by the end of the voluntary waiting period. Cows that experienced subclinical ketosis in the first week after calving, cows that had a difficult calving, or cows that had a displaced abomasum were all more likely to be diagnosed as anovular. The probability of pregnancy after first insemination was reduced in anovular cows. Further, accounting for cows that failed to become pregnant, it took approximately 30 days longer for anovular cows to become pregnant than cows that were cycling by 60 days in milk. In calculating the time to pregnancy, the daily probability of pregnancy was reduced among anovular cows beyond 140 days in milk. Anovulation represents a significant impediment to reproductive success that persists well beyond first service on some Ontario dairy farms. Transition management may offer the best solution to mitigate its impact.

13 Using the histone H2a transcript as an endogenous standard to study relative transcript abundance during bovine early development

Molecular Reproduction and Development, January 2007, Volume 74, Number 6, pages 703-715.

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The study of embryonic development through comparative gene expression analyses is impaired by the absence of a suitable across stage reference for normalization purposes. The main objective of this project was to study the abundance of RNA molecules coding for histone H2a during the early developmental period ranging from the germinal stage oocyte to the blastocyst embryo to confirm its potential as a reference gene. Another objective was to evaluate the impact of in vitro settings on the quantity levels of 3 standardization candidates at the blastocyst stage. Researchers collected bovine ovaries at a slaughterhouse and transported them to the laboratory, where those ovaries were cumulus-oocyte complexes were taken, maturated in vitro, and fertilized also in vitro. The RNA concentration of specific targets (for example: histone H2a.1, H2a. z, etc.) was measured during the development stage ranging from immature oocyte to the blastocyst embryo. The origin of the transcripts (from either de novo transcription or maternal stocks) and the state of polydenylation were taken into account in order to assess with more evidence the conditions affecting the RNA concentration measurement of those candidates. Researchers found histone H2a. z only in a polydenylated state but histones H2a.1 and H2a.o were found in larger quantities in a nondelynated form. Another finding is the impact of serum, present in the in vitro embryo development media, on the histone H2a.1 RNA level when that histone is at the blastocyst stage. The study concluded that normalization of data is an important issue facing difficult challenges because of the variety of candidates having different characteristics.

14 Use of somatic cell nuclear transfer to study meiosis in female cattle carrying a sex-dependent fertility-impairing X-chromosome abnormality

Cloning and Stem Cells, January 2007, Volume 9, Number 1, pages 118-129.

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In humans and domestic animals, abnormalities of the X-chromosome results in malformations, spontaneous abortions, infertility, and premature germ cell depletion. Studying meiotic events in female animals has always been difficult because of the limited access to fetal oocytes. In this project, scientists were able to create embryos, fetuses and calves using somatic cell nuclear transfer. Researchers worked with 33 replicates involving 2470 oocyte-donor-cell complexes. After evaluation for evidence of blastocyst development, 42 blastocysts were implanted to 21 recipients. After 35 days of gestation, 14 pregnancies were identified on the initial 21 blastocysts. Three of these 14 pregnancies resulted in calving and one was stopped on day 94 for ovary retrieval on the fetus. A laboratory examination was conducted to study the characteristics of oocytes from ovaries of the unborn calf, and from ovaries of the three newborn calves. Results from the pachytene spreads analysis showed that 16 % had quadrivalent structures, 82 % had trivalent/univalent structures, and 1.5 % had bivalent/univalent/univalent structures. Examination of the diakinesis/metaphase I spreads revealed the following configurations: 16 % ring, 75 % chain and 8.3 % bivalent. These findings suggest that synaptic errors in a major proportion of oocytes may be the cause of low fertility in female carriers. The study concluded that embryos, fetuses and newborn clones can be produced by somatic cell nuclear transfer, using fibroblasts housing the x-autosome translocation.

15 Gonadotropin- dependent regulation of bovine pituitary adenylate cyclase-activating polypeptide in ovarian follicles prior to ovulation

Reproduction : The Official Journal of the Society for the Study of Fertility, February 2007, Volume 133, Number 2, pages 441-453.

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Pituitary adenylate cyclase-activating polypeptide (PACAP) is a peptide isolated for the first time in 1989 from the ovine hypothalamus. Hypothalamus, ovary, testis, and pituitary gland are regions where the activity of PACAP is expressed. Studies conducted with rodents and mice have resulted in findings suggesting the possible role of PACAP in reproduction. The 2 objectives of this experiment were to 1) describe the PACAP complementary deoxyribonucleic acid (cDNA) and its gonadotropin-dependent regulation in preovulatory follicles of cattle before ovulation, and 2) to assess the effect of PACAP on the production of genes related to ovulation. Researchers isolated PACAP cDNA using the reverse-transcriptase polymerase chain reaction method. Over a period of 24 hours, the level of PACAP messenger RNA was low at 0 hours, followed by a sharp increase at 6 and 12 hours, and then decreased at 18 and 24 hours after human chorionic gonadotropin. The levels of PACAP messenger RNA were also high in intestine, testis, uterus, and pituitary gland, but were low in all other tissues. The study concluded with 3 main findings: 1) a demonstration was made of the gonadotropin-dependent regulation of PACAP messenger RNA in cattle follicles before ovulation, 2) PACAP stimulates on the production of genes during ovulation, 3) protein kinase A activation plays an important role in the activity of PACAP in granulosa cells.

16 Synchronization of estrus and pregnancy risk in anestrous dairy cows after treatment with a progesterone-releasing intravaginal device

Journal of Dairy Science, March 2007, Volume 90, Number 3, pages 1139-1148.

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Failure to return to a predictable estrus cycle before the end of the voluntary waiting period has long been associated with reduced reproductive performance. Research from around the world indicates that on average 20% of lactating dairy ovulate for the first time after 60 days in milk. These cows have a lower probability of pregnancy at first artificial insemination, and a higher risk of overall pregnancy failure. The objective of this project was to evaluate the impact of progesterone releasing intravaginal device on synchronization of estrus, probability or pregnancy after first AI, and time to pregnancy. A total of 534 lactating Holstein dairy cows in 4 herds that had failed to display estrus by 66 days in milk were randomly assigned to receive a progesterone-release intravaginal device (268 cows) or a placebo intravaginal device (266 cows). The devices were removed after 7 days and the cows received an injection of prostaglandin. Cows were inseminated at observed estrus. Progesterone effectively synchronized estrus, however, the probability of pregnancy was not improved. It is important to note that cows receiving the placebo device were inseminated later, at a natural fertile heat. Therefore, a more accurate estimate of the impact of progesterone therapy on reproductive success in this experiment was time to pregnancy. Overall time to pregnancy was reduced in progesterone treated cows. The study concluded that the progesterone-releasing intravaginal device is efficient tool to induce estrus in anestrous cows and reduce time to pregnancy.

17 The effect of a progesterone releasing intravaginal device (PRID) on pregnancy risk to fixed-time insemination following diagnosis of non-pregnancy in dairy cows

Theriogenology, March 2007, Volume 67, Number 5, pages 948-956.

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The probability of pregnancy per fixed-time artificial insemination (PR/FTAI) depends on a number of factors such as: the proportion of animals cycling, the phase of estrous cycle at the beginning of the synchronization protocol, and compliance to that synchronization protocol. It is important that dairy cows not detected in estrus following insemination be re-inseminated as quickly as possible so they can become pregnant. The objective of this project was to assess the difference between PR/FTAI and the time to pregnancy. A total of 415 cows from 25 farms were randomly assigned to receive a progesterone-releasing intravaginal device (208 cows) or a placebo intravaginal device (207 cows). All the cows received an injection of gonadotropin releasing hormone on the first and ninth days of the experiment. The intravaginal devices were removed after 7 days and every cow received an injection of prostaglandin. All cows were inseminated on day 10. Progesterone therapy increased the probability of pregnancy after fixed-time insemination by 8 percentage points (43.8% vs 34.9%). Intravaginal progesterone therapy, included within an ovsynch protocol, in cows diagnosed not pregnant is an efficient tool to impact the probability of pregnancy at fixed-time AI.

18 Low-density lipoprotein receptor-related protein 8 (LRP8) is upregulated in granulosa cells of bovine dominant follicle: Molecular characterization and spatio-temporal expression studies

Biology of Reproduction, March 2007, Volume 76, Number 3, pages 466-475.

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Lipoprotein receptor-related protein 8 (LRP8) is a member of the low-density lipoprotein receptor family that participates in signal transduction and endocytosis. In order to verify if the expression of LRP8 is associated with follicular growth, this project was conducted with the following objectives : 1) to characterize the bovine LRP8 complementary deoxyribonucleic acid (cDNA), 2) to analyze the expression of LRP8 messenger RNA and protein in bovine follicles, and 3) to assess messenger RNA expression of proteins that interact with LRP8, such as DAB1, MAPK8IP1, MAPK8IP2, and RELN. Researchers observed a higher level of LRP8 activity in granulosa cells of dominant follicles, compared to other follicles and corpus luteum. No change was observed on the activity of other receptors such as the very-low-density lipoprotein and low-density-lipoprotein receptors. LRP8 was exclusively expressed in granulosa cells. Analysis of LRP8 messenger RNA in follicular walls over time, revealed a decrease of LRP8 starting 12 hours after human chorionic gonadotropin treatment. The study concluded that, during final follicular growth and ovulation, LRP8, RELN and MAPKIP1 messenger RNAs are differentially expressed. LRP8 is a marker of follicular dominance. It suggests that final follicular growth involves interaction of LRP8, RELN and MAPKIP1.

19 Temporal expression of factors involved in chromatin remodeling and in gene regulation during early bovine *in vitro* embryo development

Reproduction : The Official Journal of the Society for the Study of Fertility, March 2007, Volume 133, Number 3, pages 597-608.

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Mammalian oocytes must collect proteins and messenger RNAs as they grow and mature. This will allow the zygote (the first complete cell) to divide and multiply to eventually become an embryo. The period of time between the immature oocyte and the formation of the blastocyst is crucial as many important events occur during that stage. Therefore, it is important to have a better understanding of the mechanisms at work in order to build the scientific knowledge base related to the complete epigenetic process. The objective of this experiment was to evaluate the activity over time of 15 key regulator proteins associated with RNA, methylation of DNA or histone, modification or silencing of chromatin, and transcription regulation, during the period of early embryo development (before implantation). Researchers used the real-time reverse transcriptase-polymerase chain reaction method to measure, in the oocyte and during the complete *in vitro* development of bovine embryo, the quantity of messenger RNA levels in the following 15 proteins : EHMT1, EHMT2, ATF7IP, DMAP1, JARID1A, JARID1B, HELLS, JMJD1A, JMJD2A, LSD1, MeCP2, PRMT2, PRMT5, METTL3, and RCOR2. The study concluded that, during the development stages tested in this experiment, all 15 key regulating proteins were present but to different levels. Those proteins can be divided in 3 distinct groups based on their individual messenger RNA characteristics.

20 High levels of p66(shc) and intracellular ROS in permanently arrested early embryos

Free Radical Biology and Medicine, April 2007, Volume 42, Number 8, pages 1201-1210.

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Developmental arrest of one of the main causes of embryo loss when they are produced *in vitro*. Reactive oxygen species play a role in the defective development of embryos. When the level of ROS produced by those embryos increases too much, it induces an oxidative stress that can seriously damage cell structures. The objective of this research was to evaluate the effect of oxidative stress levels associated with embryo arrest on the activity of genes related to senescense in embryos produced under various oxygen conditions. Compared to embryos produced in environments containing less than 5 % oxygen, those produced with less than 20 % oxygen conditions had about 10 times more oxidative stress, a percentage of 2 to 4 cells arrest twice as high, and a significant decrease in their developmental potential. A real-time polymerase chain reaction analysis and the semiquantitatve immunofluorescence method revealed levels of protein and p66(she) messenger RNA significantly higher in embryos produced under 20 % oxygen compared to those produced under 5 % oxygen. The study concluded that the level of protein p66(she) (a stress adaptor regulating ROS metabolism, cellular degradation and apoptosis) is significantly higher in embryos having a higher number of arrests and large quantities of ROS in their cells.

21 Structure of the bovine VASAP-60/PRKCSH gene, functional analysis of the promoter, and gene expression analysis

Gene (Amsterdam), April 2007, Volume 391, Number 1-2, pages 63-75.

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Vacuolar system-associated protein-60 (VASAP-60) was first described in year 2000 after being found in bovine luteal cells and ovarian granulosa cells. Subsequent studies identified the presence of this particular protein in several other tissues. This bovine protein is the same as the human protein kinase C substrate 80K-H (PRKCSH). The biological role of VASAP-60/PRKCSH protein is unknown. The objectives of this project were to describe the bovine VASAP-60/ PRKCSH gene structure and promoter, to identify the elements regulating the activity of VASAP-60, and to study the expression of messenger RNA and splice variants in ovarian follicles. Since VASAP-60 protein was found in luteal and granulosa cells, researchers worked with ovarian follicles at various stages of development. They reported that the bovine gene is made of 18 exons and 17 introns. The level of expression of VASAP-60 messenger RNA was 2.4 times higher in granulosa cells of dominant follicles, compared to ovulatory or small follicles. The study concluded that expression of VASAP-60 was up-regulated in granulosa cells of dominant follicles, the structure of the bovine VASAP-60 gene was elucidated, and that functional analysis of its promoter showed that the transcription factor YY1 acts as a potential positive transcriptional regulator.

22 Management of infertility due to unilateral segmental aplasia of the paramesonephric (Mullerian) duct in Holstein Friesian cattle – a case-based review and update

Bovine Practitioner, Spring 2007, Volume 41, Number 1, pages 24-31.

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Segmental aplasia of the paramesonephric duct (SAP) may be a cause of infertility in cattle and other animals. SAP is not mortal disease but it affects negatively the production of new calves. Scientifically reported for the first time in the early 1900s in Shorthorn cattle, it seems to affect only the genital region of the animals, inducing partial or complete developmental failure of uterine body and/or uterine horns. SAP is not a common disease, only 0.15 and 0.45 % of the cattle population around the world has been diagnosed positive and, since 1973, only 2 cases involving North American Holstein cows have been described in scientific literature. The objective of this study was to evaluate the condition of 17 Holstein Friesian cows recently diagnosed positive to SAP. Affected animals may be cured medically or surgically to allow normal pregnancy, even is some cows may have delivered healthy calves before the positive diagnosis. The authors recommend the development of a screening test for SAP, in order to be able to measure the disease prevalence and to have a tool for management control. The study concluded that the genetic contribution of animals affected with SAP should be limited to the herd. Also, more research should be conducted to identify the gene responsible for that condition, and a centralized database should be built to record all known cases of SAP.

23 Dielectrophoretic behavior of *in vitro*-derived bovine metaphase II ooctyes and zygotes and its relation to in vitro embryonic developmental competence and mRNA expression pattern

Reproduction: The Official Journal of the Society for the Study of Infertility,
May 2007, Volume 133, Number 5, pages 931-946.

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Scientists produce *in vitro* bovine embryos by retrieving oocytes from cattle ovaries supplied by slaughterhouses. However, this method often results in failures because the oocytes have very different characteristics affecting their successful development. To increase the chances of success, oocytes are now selected to retain only those having the best chances of success (those resulting in competent and transferable blastocysts). The objective of this project was to study the efficacy of the dielectrophoresis method to assess the competency of oocytes and zygotes, in replacement of the traditional and time-consuming observation under microscope. Dielectrophoresis is the application of a non-uniform electric field to living cells, resulting in the motion of neutral particles. In this experiment, oocytes and zygotes were put under electric field at 4 Megahertz and at a specific distance from the electrodes. They were then classified in 4 categories (very fast, fast, slow, very slow) depending on the time spent to reach one of the electrodes. Researchers observed a positive correlation between the speed of oocytes and zygotes, as measured with the dielectrophoresis method, and the rate of development of embryos: higher for faster oocytes and zygotes, and lower for slower oocytes and zygotes. Furthermore, an additional analysis revealed that several transcripts were regulated differently between the fastest and slowest oocytes and zygotes. The study concluded that dielectrophoresis successfully separated oocytes and zygotes having different blastocyst development and transcriptional regulation.

24 Stability of bovine milk progesterone under different storage and thawing conditions

Canadian Journal of Animal Science, June 2007, Volume 87, Number 2, pages 123-128.

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The objective of this research was to evaluate the stability of bovine milk progesterone under five different storage or thawing conditions over a period of 8 weeks. The five conditions were: 1) use of a preservative agent, Brotab 10®; 2) storage temperature (either 4 or 21 ºC); 3) thawing temperature (either 4, 21 or 37 ºC); 4) length of storage at –20 ºC; and 5) repeated freeze-thaw cycles. Researchers collected whole-milk samples from 19 pregnant dairy cows and used the Quanticheck® enzyme immunoassay test for analysis. They found that, during the first 3 to 7 days, progesterone level in bovine whole milk declined significantly regardless of storage temperature. Progesterone remained stable for longer periods at low temperatures (4 or –20 ºC), even if no preservative was added. Adding preservative helped to slow the decline of progesterone and this was particularly evident when the milk was at room temperature. The stability of natural milk progesterone was unaffected by thawing temperatures, and repeated freeze-thaw cycles did not affect progesterone concentrations beyond 14 days. The study concluded that, for up to 3 days, progesterone is stable when whole-milk is kept at 21ºC. That stability can be extended to 14 days if the milk temperature is lowered to 4 ºC. For storage longer than 14 days, it is preferable to store whole-milk at –20 ºC to preserve progesterone stability.

25 Effects of manipulating the nitric oxide/cyclic GMP pathway on bovine oocyte meiotic resumption *in vitro*

Theriogenology, September 2007, Volume 68, Number 5, pages 693-701.

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There is a possibility that cyclic guanosine monophosphate (cGMP) plays a role in the nuclear maturation of oocytes. This hypothesis is based on studies revealing the inhibitory and stimulatory effects of cGMP compounds on the spontaneous nuclear maturation of rats and hamster oocytes. The objective of this project was to study the effects of altering the nitric oxide/cyclic guanosine monophosphate (NO/cGMP) pathway on the nuclear maturation of bovine oocytes *in vitro*. Researchers recovered cumulus-enclosed oocytes from ovaries supplied by a slaughterhouse, and cultured them for either 7 or 21 hours in M199 medium supplemented with fetal calf serum and molecules known for having an effect on the NO/cGMP pathway. The oocytes were then evaluated to assess the stage of nuclear maturation. The analysis revealed the significant inhibiting effect of aminoguanidine, sodium nitroprusside on germinal vesicle breakdown after 7 hours of culture. The effects of aminoguanidine and sodium nitroprusside could be reversed, a sign of their non-toxicity. Sodium nitroprusside, Protoporphyrin IX and atrial natriuretic peptide increased the levels of cyclic guanosine monophosphate after 3 hours of culture but not after 6 hours. The study concluded that it was possible to activate particulate and soluble guanylate cyclases in bovine cumulus-oocyte complexes.

26 Amplification and application of the HMG box of bovine SRY gene for sex determination

Animal Reproduction Science, July 2007, Volume 100, Number 1-2, pages 186-191.

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The SRY gene was discovered in 1990. It is the only Y gene necessary for the formation of testes. Several efficient methods involving the amplification of specific Y chromosome sequences have been developed for sex identification of bovines when they are still at the embryo stage. The objective of this research was to develop a polymerase chain reaction method to identify the sex of bovine embryos, based on the amplification of the high mobility group (HMG) of the Y chromosome gene (SRY). Researchers used the polymerase chain reaction method to identify the sex of 14 embryos from biopsy samples. On that same day (7^{th} day of the estrus cycle), following the procedure of sex identification, the embryos were implanted into 14 recipient cows. As a result, 9 calves were born from those 14 embryos, and all animals had a sex type corresponding to the sex type identified by polymerase chain reaction. This corresponded to a 100 % accuracy of the method. The study concluded that, for the first time, a polymerase chain reaction method was used successfully to identify the sex of bovine embryos. This fast and reliable new tool will facilitate herd management, as it will be possible to manipulate sex ratios of new calves.

27 Alterations in transcript abundance of bovine oocytes recovered at growth and dominance phases of the first follicular wave

BMC Developmental Biology, July 2007, Volume 7, Number 90.

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The successful production of in vitro bovine embryos depends on several factors. At this moment, the rate of success is low because only about 30 to 40 % of the blastocysts develop to the point where they can be transferred to cows. And of those 30 to 40 %, only half will become calves. The quality of the oocytes (follicle size, morphological characteristics of the oocyte, etc.) is one of the main factors affecting the successful production of embryos. The objective of this project was to assess transcript levels of oocytes collected from small follicles during the phases of growth and dominance in the first follicular sequence. Researchers found a total of 51 genes differentially regulated. Of those 51 genes, 36 have a known function, 6 have unknown functions and the last 9 have novel transcripts. Messenger RNA and protein product of candidate gene MSX1 was identified in ovarian follicles during the estrous cycle. After fertilization, protein product of candidate gene MSX1 was found in oocytes and early embryos. The study concluded that different sets of transcripts were identified between oocytes collected from small follicles during the phases of growth and dominance in the first follicular sequence. This result was validated and supports the idea that several of those transcripts may be associated with developmental competence of oocytes.

28 Effects of adenosine monophosphate-activated kinase activators on bovine oocyte nuclear maturation *in vitro*

Molecular Reproduction and Development, August 2007, Volume 74, Number 8, pages 1021-1034.

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Adenosine monophosphate (AMP) has a strong regulating effect on adenosine monophosphate-activated protein kinase (AMPK), a serine/threonine kinase that reacts to environmental stress or changes in cellular energy demands by managing the action of enzymes of the glucose and fat metabolisms. Recent studies have suggested that AMPK could play a role in the control of oocyte nuclear maturation. AICAR (5-Aminoimidazole-4-carboxamide-1-β-D-ribofuranoside) is a compound used on a regular basis for the study of AMPK activation in several physiological events. It was used in previous experiments to activate AMPK in oocytes of mice. The objective of this project was to study the effects of AICAR (an activator of AMPK) on the nuclear maturation of bovine oocytes *in vitro*. Researchers observed a significant increase in the percentage of denuded oocytes and cumulus-enclosed oocytes remaining at the germinal vesicle stage (immature stage) after 7 hours of culture. After 22 hours of culture, the number of cumulus-enclosed oocytes able to reach metaphase II was significantly reduced by the action of AICAR. Another activator of AMPK (Metformin) was tested and that compound also inhibited germinal vesicle breakdown in denuded cumulus-enclosed oocytes. The study concluded that AMPK activators have an inhibitory effect on the nuclear maturation of bovine oocytes. The inhibitory effect seems to originate from AMPK activation, not from purine nucleotides.

29 Evaluation of early conception factor lateral flow test to determine nonpregnancy in dairy cattle

Canadian Veterinary Journal, August 2007, Volume 48, Number 8, pages 831-835.

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Reproduction is one of the most important aspects of herd management in dairy farming. In Western Canada, over 30 % of dairy cows are removed each year from herds because of reproductive problems. The early conception factor lateral flow test is a tool sold on the market for identification of nonpregnant cows beginning 6 days after breeding. The test is based on the detection of a special protein (early conception factor) that becomes detectable in the blood of pregnant cattle as early as 48 hours after mating. That protein remains detectable during the complete period of pregnancy and disappears in case of embryo death. Some studies have acknowledged the accuracy of that test but other studies have reached opposite conclusions. The objective of this project was therefore to assess the efficacy of the test for identifying nonpregnant cows. Researchers worked with 191 cows and made 832 tests during 2 field trials. Results of the tests showed an accuracy level of about 50 %. The agreement was 57.5 % between milk and serum from the same cow. Over a testing period of 4 weeks with the same cow, the test did not show consistency in its capacity to detect nonpregnancy. The study concluded that the early conception factor lateral flow test is not an accurate tool to measure nonpregnancy in dairy cows.

30 *In vivo* and *in vitro* effects of FSH on oocyte maturation and developmental competence

Theriogenology, September 2007, 68 Supplement 1:S71-6.

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Many years of scientific experiments related to ovarian stimulation have demonstrated the positive effect of providing follicle-stimulating hormone (FSH) for improving the viability of oocytes from calves, heifers and cows. In laboratory settings (*in vitro*), more than 75 % and sometimes 100 % of the oocytes become blastocysts when FSH is added to the culture media, compared to an average of only 40 % for oocytes maturing without FSH in the animals (*in vivo*). The objective of this project was to review the current knowledge about the effect of FSH on granulosa cells (*in vitro*) and cumulus cells (*in vivo*). The developmental competence of oocytes and growth of follicles are controlled by 2 different signals. The first signal occurs when the dominant follicle is differentiated, as it normally should before ovulation. The second signal happens when the dominant follicle indicates to the oocyte that conditions for embryo development are adequate. Even though FSH is probably involved in these two processes, they are very different and complex, as it was revealed by analysis of oocytes, cumulus cells and granulosa cells. To be relevant, genomic analyses must be conducted in precise settings in regard to growth and differentiation of follicles, or culture conditions. Some studies have already been made to provide a better understanding of functions of several genes associated to oocyte-follicle codifferentiation, and to the regulation of follicular growth.

31 Enhancing ultrasound texture differences for developing an *in vivo* « virtual histology » approach to bovine ovarian imaging

Reproduction, Fertility and Development, October 2007, Volume 19, Number 8, pages 910-924.

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Ultrasound imaging is used routinely to evaluate the condition of mammalian ovaries, and especially the follicles, stroma and corpora lutea. However, reading and interpreting an image from even the best ultrasound imaging equipment is a challenge because some important details are often indistinct with this technology. Virtual histology is the process of enhancing the images from ultrasonographic imaging equipment in order to have a better view of the different textures of tissues. The objective of this project was to evaluate 6 candidate algorithms (software) designed to improve the image of bovine ovaries generated by ultrasound imagers. The evaluation criteria were both quantitative (capability to increase the statistical differences in texture of ovaries) and qualitative (capability to visually enhance the differences of intra-ovarian tissues). The algorithms produced sharper definitions of follicle boundaries and some candidate software produced images of corpora lutea almost similar to actual histology. Algorithms 3 and 4 had the best performance in consistently increasing the statistical difference between corpora lutea and stroma textures. The study concluded that algorithms can enhance significantly the images generated by ultrasound imaging equipment, when used for ovarian examination. Even though the algorithms do not replace human analysis and decision making, they provide evidence that near histological images can be acquired using a safe and non-invading procedure.

32 Effects of flaxseed supplementation on endometrial expression of ISG17 and intrauterine prostaglandin concentrations in primiparous dairy cows submitted to GnRH-based synchronized ovulation

Canadian Journal of Animal Science, September 2007, Volume 87, Number 3, pages 343-352.

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Flaxseed is an important source of linolenic acid. Previous studies have reported several health benefits of adding flaxseed in the diet of cattle. The objective of this project was to assess the effects of adding 9.1 % flaxseed in the diet (compared to no flaxseed) on the survival of early embryo and on the intrauterine accumulation of prostaglandins on day 17 following ovulation. Researchers worked with 48 primiparous Holstein dairy cows from October 2003 to April 2004. The animals were divided in groups of 2 according to similarity of their expected calving date. They were housed in tie-stalls, milked twice a day, and fed with either an experimental diet containing 9.1 % whole flaxseed or a control diet containing no flaxseed. Measurements were made for feed consumption, body weight, milk production, and milk composition. Researchers observed that adding flaxseed to the diet of dairy cows resulted in an increased level of omega 3 fatty acids. However, flaxseed had little effect on milk production, except for a lower score of somatic cells in the milk of cows fed whole flaxseed. The ratio of two metabolites of series 2 prostaglandin in uterine flush was higher for non-inseminated cows fed CON than for non-inseminated cows fed FLA (17.5), thus suggesting better conditions for embryo survival when feeding flaxseed. The study concluded that feeding flaxseed before breeding might enhance uterine health, giving more chances of survival to the embryos and improving cattle fertility.

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Dairy Farmers of Canada
Les Producteurs laitiers du Canada

Réseau laitier canadien
Canadian Dairy Network

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada