日豪合同シンポジウム

JSAR and SRB Joint Symposium 2005, Shizuoka, JAPAN

9月14日(水)　15：30－18：30　第1会場（大ホール）

Towards 'Clean, Green and Ethical' Animal Reproduction

15:30-15:35 **Welcome address**
President of Japanese Society of Animal Reproduction (JSAR)
Dr. Eimei Satoh (Tohoku University, Japan)

15:35-15:40 **Opening address**
Society for Reproductive Biology (SRB)
Dr. Graeme B Martin (University of Western Australia, Australia)

15:40-15:45 **Purpose of the symposium on "Clean, Green and Ethical Animal Reproduction"**
Dr. Taku Nagai (National Institute of Livestock and Grassland Science, Japan)

Session 1 Chaired by Dr. Scott Mcdougall (Animal Health Center, New Zealand) and Dr. Keiichiro Maeda (Nagoya University, Japan)

15:45-16:10
1. Natural methods for increasing reproductive efficiency in small ruminants.
Dr. Graeme B Martin (University of Western Australia, Australia)

16:10-16:35
2. A potential use of color ultrasound as a tool for reproductive management: New observations using color ultrasound scanning that were not possible with imaging only in black and white.
Dr. Akio Miyamoto (Obihiro University of Agriculture and Veterinary Medicine, Japan)

16:35-17:00
3. New strategies for the reproductive management for lactating dairy cows, based on the relationship between leptin activity, other factors related to adipose tissue, and reproductive function.
Dr. Hiroya Kadokawa (National Institute of Livestock and Grassland Science, Japan)

Session 2 Chaired by Dr. Graeme B Martin and Dr. Hiroya Kadokawa

17:00-17:25
4. The impact of nutrition of the cumulus oocyte complex and embryo on subsequent development in ruminants.
Dr. Jeremy G. Thompson (University of Adelaide, Australia)

17:25-17:50
5. The dairy cow knows her problem best: searching for a breakthrough for reproductive problems in Japan.
Dr. Ken Nakada (Rakuno Gakuen University, Japan)

17:50-18:15
6. Reproduction management and performance of New Zealand dairy cattle.
Dr. Scott McDougall (Animal Health Centre, New Zealand)

18:15-18:25 **General Discussion** Chaired by Dr. Graeme B Martin and Dr. Akio Miyamoto

18:25-18:30 **Closing Address**
Dr. Masugi Nishihara (University of Tokyo, Japan)
Dr. Graeme B Martin

Towards 'Clean, Green and Ethical' Animal Reproduction

Hiroya Kadokawa[1], Graeme B. Martin[2], Akio Miyamoto[3], Taku Nagai[4]

[1]Department of Animal Breeding and Reproduction, National Institute of Livestock and Grassland Science, Nasushiobara, Tochigi 329-2793, JAPAN
[2]School of Animal Biology, Faculty of Natural and Agricultural Sciences, The University of Western Australia, Crawley 6009, AUSTRALIA
[3]Graduate School of Animal and Food Hygiene, Obihiro University of Agriculture and Veterinary Medicine, Obihio 080-8555, JAPAN
[4]Department of Research Planning and Coordination, National Institute of Livestock and Grassland Science, Tsukuba, Ibaraki 305-0901, JAPAN

Purpose of this Joint Symposium

Our animal industries are becoming increasingly influenced by societal constraints that are inevitably leading to changes in the marketplace: consumers worldwide are beginning to demand products that are "clean, green and ethical". In Japan for example, BSE, mouth-foot disease, and illegal activities by Japanese butchers have led consumers to question the practices of all members of animal industries. We can begin with producers - they need to adopt practices that minimise or completely avoid chemical and hormonal treatments of animals, and avoid practices that compromise the welfare of their animals. Indeed, in many countries, regulatory authorities have already imposed these conditions on local producers, importers and exporters. However, clean, green and ethical practices need not be difficult or costly - they should arise from a better understanding of the physiology and behaviour of the animals and therefore improve productivity and profitability.

To prepare for this future, our industries need a long-term vision with clear goals, supported by research and development programs that will lead to these goals. In this international seminar, we will be discussing new research that should promote the development of such a vision. There will be a focus on the management of reproduction because, to a large extent, the productivity and profitability of our meat and milk industries depend on reproductive performance.

The first speaker is Dr. Graeme B. Martin who has been promoting the use of "clean, green, and ethical reproductive management". His basic ideas were developed for small ruminants but many of them can be transferred to cattle after more studies. The first area of discussion will be advanced in electronics that are improving ultrasound. Ultrasound may not seem to fit preconceived ideas of a green technology, but they are non-invasive and non-hormonal and they can provide important information about the status of the reproductive process in breeding animals. Dr. Akio Miyamoto has recently been using the power of color ultrasound and they have made discoveries that were not feasible using only black-and-white imaging. The third and fourth presentations are focused on nutrition, because nutritional management is an integral part of Martin's proposal and because nutrition is often the biggest cost in animal production. We therefore invited Dr. Hiroya Kadokawa to bring us up to date about leptin, a cytokine-hormone secreted by adipose tissue that affects reproductive function in sheep and dairy cows, and Dr. Jeremy G. Thompson to bring us up to date on the impact of the nutrition of the oocyte and embryo on subsequent development in ruminants. Next, we will hear a talk about the goal for reduced use of medicines for dairy cattle in Japan by Dr. Ken Nakada. He will discuss the relationships between changes in nutritional, immunological, and reproductive parameters during late lactation and drying-off periods, and subsequent postpartum reproductive performance from the point of view of a veterinary scientist. Finally, before beginning a general discussion, we will hear from Dr. Scott McDougall who will discuss dairy cattle reproduction from the perspective of a seasonal, pasture-based production system in New Zealand, so we can compare the industries of the two countries.

Natural methods for increasing reproductive efficiency in small ruminants

Graeme B. Martin

School of Animal Biology, Faculty of Natural and Agricultural Sciences,
The University of Western Australia, Crawley 6009, Australia

This paper describes three strategies to improve the reproductive performance of small ruminants in ways that lead to "clean, green and ethical" animal production. The first is aimed at control of the timing of reproductive events for which we turn to the socio-sexual inputs of the "male effect" to induce synchronised ovulation in females that would otherwise be anovulatory. The second strategy, "focus feeding", is based on our knowledge of the responses to nutrition and aims to develop short programs of nutritional supplements that are precisely timed and specifically designed for individual events in the reproductive process, such as gamete production, embryo survival, fetal programming, and colostrum production. The third strategy aims to maximize offspring survival by a combination of management, nutrition and genetic selection for behaviour (temperament). All of these approaches involve non-pharmacological manipulation of the endogenous control systems of the animals and complement the detailed information from ultrasound that is now becoming available. Importantly, these approaches all have a solid foundation in reproductive biology and, in several cases, they are currently used in commercial practice. However, there is still room for improvement through both basic and applied research - the established tools are not always efficient and, for the tools that are more speculative, we need a better understanding of how they work so we can develop them further. Ultimately, we will need "clean, green and ethical" tools for the management of our animals. With good science, they can be cost-effective, increase productivity and, at the same time, greatly improve the image of meat and milk industries in society and the marketplace.

A potential use of color ultrasound as a tool for reproductive management: New observations using color ultrasound scanning that were not possible with imaging only in black and white

Akio Miyamoto

Graduate School of Animal and Food Hygiene,
Obihiro University of Agriculture and Veterinary Medicine, Obihio 080-8555, Japan

Ultrasonography (US) has been applied to the ovary and the uterus of domestic animals from the late 1980s, and established in 1990s as a practical tool for animal production. US made it possible to detect pregnancy at a very early stage and, most importantly, to observe the real-time dynamics of follicular development and hence the discovery of follicular waves. This has greatly contributed to our understanding of ovarian physiology and helped us to develop several "pin-point" protocols for hormonal treatment. While US may not seem to fit preconceived ideas of a "green" technology, it does not contravene environmental priorities, and it is non-invasive ("ethical") and non-hormonal ("clean"). Using the US technology that is now commercially available at a reasonable price, we are able to estimate the best timing for AI and this allows us to plan either the use of precisely-timed nutritional supplements for fetal development or an immediate 2nd AI service to achieve a better economic efficiency. During the last few years, we have also begun to be able to observe in detail the local blood flow in individual ovarian follicles and CL using color Doppler ultrasonography in the cow. From the series of observations, we have found that: 1) the change of blood supply to an individual follicle closely relates to the dynamics of follicular growth and atresia; 2) the local blood flow detected in the theca externa of mature follicles rapidly increases around the onset of LH surge and is most active before ovulation; 3) the blood supply to the developing CL increases in parallel with CL volume and plasma progesterone concentrations; and 4) the local blood flow surrounding the mature CL acutely increases prior to the onset of luteolysis in response to uterine as well as exogenous PGF2□. It is now clear that color Doppler ultrasound is very useful for observing echogenicity with local blood flow thereby providing an easily obtained estimated of the physiological status of follicles and CLs. Undoubtedly, cost, performance and ease-of-use are essential if color US is to become popular, and this must await further development of the technology. Overall, US is now a most effective non-invasive tool for managing reproduction, at the level of both the individual animal and the herd system. In particular, US can help us to clarify potential problems in high-producing dairy cattle during the postpartum period.

New strategies for the reproductive management for lactating dairy cows, based on the relationship between leptin activity, other factors related to adipose tissue, and reproductive function

Hiroya Kadokawa

Laboratory of Reproductive Physiology, Department of Animal Breeding and Reproduction, National Institute of Livestock and Grassland Science, Nasushiobara, Tochigi329-2793, Japan

The "clean, green and ethical" management tools, that are cost-effective and easy to use for farmers, are needed also for high producing dairy cows. Thus, we need to develop specific tools, because they are needed for artificial insemination after oestrus detection by humans only a few months after the calving and for managing their complex nutritional requirements between the calving and the subsequent calving. The rough assessment of energy shortage by measuring body condition score has been useful for reproductive management. To improve our knowledge of the relationship between adipose tissue and fertility, this paper reviews the recent studies on leptin, a cytokine-hormone secreted by mainly adipose tissue that seems to affect the reproductive system. In postpartum dairy cows, leptin seems to be linked to the postpartum first ovulation and also pulsatile LH release. Adipocytes in the body are always sensing energy status and they control leptin secretion dynamically, so blood leptin concentrations can change even during short periods when there is no detectable change in body condition score. Plasma leptin values seem to be determined by both the mass of adipocytes secreting leptin, which may be roughly measured by body condition score, and the secreting activity of the each adipocyte. The relationship between body condition score, leptin activity, and reproductive function in dairy cows suggests that we should reconsider the need for high milk yields early in the postpartum period and at the beginning of dry period. We should also re-assess the current drive to reduce calving interval because milk yields during the early stages of lactation are economically very important but, in modern dairy cows, high yields seem to cause metabolic and reproductive problems. In general, the thinking has been that calving interval must be short because short intervals are more profitable. However, if we remember that main product from dairy cows is milk and that a short calving interval is very difficult without reproductive problems in modern dairy cows, then a longer calving interval might be more sensible. Probably, we need to improve dairy cows genetically if they are to achieve the goal of "clean, green and ethical" dairy farming. In conclusion, we need more basic and applied researches if we are to obtain a road map that will allow us to reach that goal.

The impact of nutrition of the cumulus oocyte complex and embryo on subsequent development in ruminants

Jeremy G. Thompson

Research Centre for Reproductive Health, Dept. Obstetrics and Gynaecology,
The University of Adelaide,The Queen Elizabeth Hospital, Woodville, SA 5011, Australia

Cumulus-oocyte complexes (COCs) and early embryos rely on a histotrophic nutrition source for energy production and the synthesis of macromolecules. There is accumulating evidence suggesting that the balance of supply and demand for energy and other anabolic substrates during oocyte maturation and very early stages of development programmes subsequent developmental potential, including fetal and placental growth. The concept that fetal growth is influenced by imbalances in the environment that oocytes and embryos are exposed to has emerged from work in embryo culture and subsequent embryo transfer. However, this is not restricted to just in vitro environments, as we are revealing how diet and lifestyle at conception can influence long-term development. One example is the previously unheralded role of glucose (Glc) metabolism through the hexosamine biosynthesis pathway (HBP) during COC maturation in vitro. Our laboratory has shown that Glc is an important regulatory substrate for the bovine COC during maturation and essential for normal development. Glucosamine (GlcN) is a related hexose to Glc, but directly enters the HBP below the pathway 1 s rate-limiting enzyme. Addition of GlcN during cell culture markedly up-regulates the HBP. Surprisingly, addition of GlcN during bovine oocyte maturation in vitro, in a dose-dependent manner, inhibits blastocyst development without inhibition to either meiotic maturation, fertilization or early cleavage, demonstrating that up-regulation of the HBP in the COC during in vitro maturation leads to programming for failure of post-compaction embryo development. The HBP in somatic cells is regarded as a "fuel-sensing" pathway and its interaction with cell signalling systems and transcriptional regulation is increasingly apparent. Another example is the role of hypoxia (low O2) during peri-compaction development. We have found significant species differences in hypoxic responses between mouse and cattle embryos. This appears to be due to differences in the activity of oxygen-sensitive transcription factors between these two species. We believe that ruminant embryos during compaction, blastulation and subsequent development in the uterine cavity lack a key hypoxia responsive element. Because of this, hypoxia is important for normal development in ruminants but perturbs further development in rodents. The implication of these examples to the fundamental concept of peri-conception nutritional programming of development will be discussed.

The dairy cow knows her problem best: searching for a breakthrough for reproductive problems in Japan

Ken Nakada

Department of Large Animal Clinical Sciences, Rakuno Gakuen University,
Hokkaido 069-8501, Japan

Reproductive efficiency and performance in dairy cattle has been declining during last 20 years in Japan, and this has resulted in serious problems in dairy herds. There have been various changes in the animals themselves and in the environment to surround the animals in the background, e.g. milk yield by the genetic improvement has risen, herd size of dairy farm has been expanding, housing system of dairy cattle has been changing tie stall to free stall, and feeding system of TMR (total mixed ratio) has become widespread to the farms. It is not clear whether the animals have adapted sufficiently to these environmental changes. Up to now, execution of reproductive control using monitoring system for the animals and/or hormonal treatments, has resulted in moderate reproductive performance. However, conception and pregnancy rates have continued to decline, and the calving to calving interval has continued to extend. Consequently, the average parity and the average age at culling in dairy cattle has been declining. The most common causes of culling in dairy cattle are reproductive disorders. Therefore, future prevention of the reproductive disorders will be required to improve reproductive efficiency. During late pregnancy and the transition from the pregnant, non-lactating state to the non-pregnant, lactating state, dramatic changes in the dam are occurring including an increase in the fetal-placental mass and calving. Thus, the demand for energy, protein and minerals in the conceptus increases, the space of the abdominal cavity and the rumen capacity decreases to take the pressure of the conceptus, the local immunological response between fetal and maternal placenta dramatically changes, and physiological homeostasis activates to adapt these changes at this time. If the cattle can't maintain the homeostasis before calving, the incidence of reproductive diseases in the cattle will greatly increase. We have been examining reproductive, nutritional and immunological factors to predict the occurrence of reproductive disorders as early as possible and to develop strategies to prevent them. It is unlikely that all dairy farms in Japan will be able to improve reproductive performance with general advise, due to the wide variation in feeding systems and management. Therefore, specific advice needs to be tailored to each herd, based on management systems employed on each herd. We have proposed that it is important to identify common risk factors across herds, to use these factors as an index for disease control and reproductive management and finally to demonstrate the relationship between these factors and fundamental improvement of the reproductive efficiency. We propose this approach with the aim of providing a breakthrough to solve reproductive problems in cows.

Reproduction management and performance of New Zealand dairy cattle

Scott McDougall

Animal Health Centre, PO Box 21, Morrinsville, New Zealand

New Zealand dairy herds are predominantly pasture-fed and calve all cows over a 8 to 12 week period in spring. This system has a relatively low input of feed other than pasture with a resultant low cost of production and relatively milk production per cow. The seasonal calving system requires a high level of reproductive performance to ensure a 365 day inter-calving interval. About 85% of cows are detected in oestrus and inseminated in the first 21 days of the seasonal breeding programme and have a conception rate of 55% to 65% to this first insemination. This results in ~60%, ~80% and ~90% of cows being pregnant by 4 and 8 weeks into the breeding programme and by the end of the 12 to 14 week breeding programme, respectively. However, reproductive performance is declining. Factors associated with this may include increasing herd size, reduced oestrus detection sensitivity and specificity, declining body condition score at calving and increased rate of body condition score postpartum and increased cow milk production. Thus although reproductive performance of New Zealand dairy cows is good by international standards, continued research and extension are required to maintain this level of performance.