Section XI

Animal Science's Program Analysis and Future Direction

A. Future of Livestock Extension

Minnesota Livestock Extension programs have been very successful in providing unbiased research based information and programs to the livestock industries of the State for many years. Recent reductions in state support, a recent flat trend in federal support, and increased costs have mandated a significant downsizing by the Extension Service in both personnel and allocated funding. Minnesota has developed a new regional model of Extension to meet these challenges.

There are 18 regional centers with 9 regional extension educators (REEs) having beef, dairy, swine or manure systems expertise located at some of these locations (see Diagram 1). Minnesota is ranked 10th nationally in beef production. There are around 15,500 beef producers scattered across the state with cow calf heifers in the SE and Northern counties and beef feed lots in SW Minnesota. Minnesota dairy production is ranked 6th nationally. The 6500 dairy farms are represented by the red dots on Diagram 1. All dairies in Minnesota have GIS coordinates maintained by MDA. Specific geographic locations are not available for other species at this time. Swine production is ranked 3rd in the US. The 6200 swine farms are distributed over the southern third of the State. Poultry production is another very important livestock entity in Minnesota with turkey production and processing ranking 1st in the US. The majority of poultry production is concentrated in west central Minnesota and all Extension programming comes from campus faculty. Not all 87 Minnesota counties have agricultural educators anymore. Approximately half of the counties in the State have maintained local extensions educators (LEEs) in agriculture. Around a dozen of these LEEs are in counties that are expecting them to focus a large part of their time on livestock programs and one-on-one technical assistance to livestock producers. This represents a significant net loss in livestock programming at the local level except in those counties who have LEEs with livestock expertise.

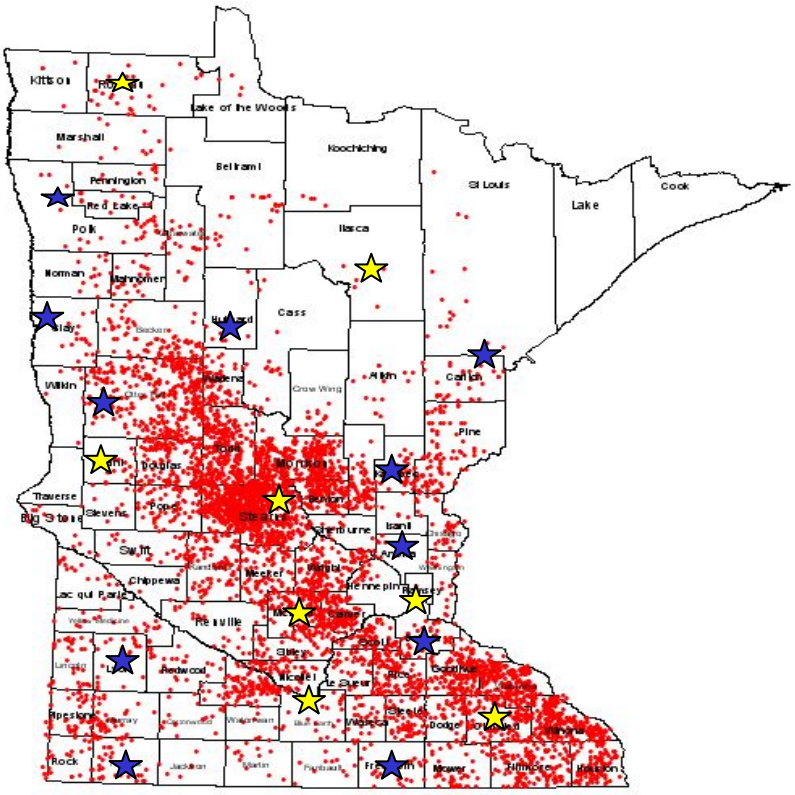

Diagram 1: Stars indicate the location of the Regional Extension Centers. The yellow stars indicate where the Livestock REEs are located.

There are 29 program teams within the AFE (Agriculture, Food and Environment) "capacity area" of which 7 teams have livestock interest:

- Beef production
- Dairy Modernization
- Horse Program
- Manure Management Education
- Poultry Production and Health
- Swine Production Technology
- Food Safety and Food Service

Program Teams consist of campus faculty, REEs and LEEs and are lead by campus extension faculty. Each team is responsible for all extension programming in that particular area of expertise. Administrative supervision of all REEs is the responsibility of the livestock area program leader (APL) who is an Extension faculty member of DAS. Therefore, the overall supervision of all livestock extension programs is now the responsibility of the Head of the Animal Science Department (see Diagram 2).

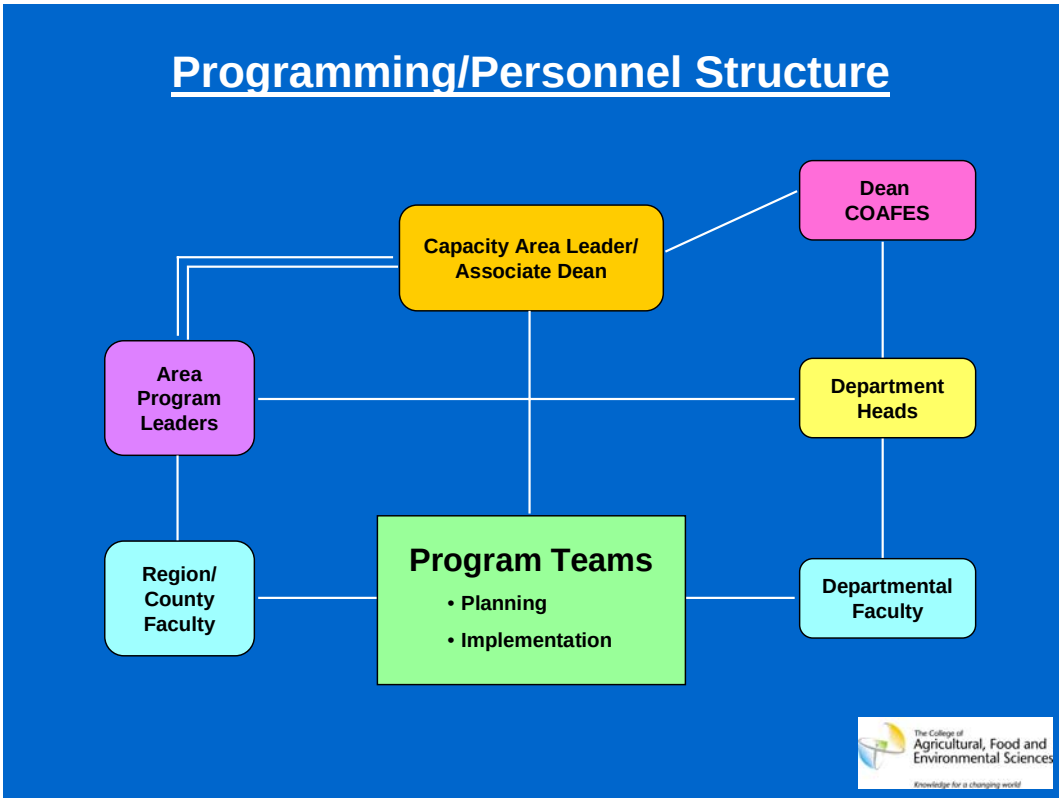

Diagram 2: New Regional Extension Administrative Structure

State Specialists and Regional Livestock Educators have been encouraged to explore alternative methods of disseminating information other than traditional face-to-face meetings to reduce delivery costs. Entrepreneurial program planning and execution have been implemented on the basis of business plans for each program team. Integration of State and Regional programming has shifted further away from a service orientation but has been working hard to integrate with local county educators as much as possible without over-stretching the current limitations of a shrinking staff (see Diagram 3). "Case #3" is considered the desired model for ideal program integration. Extension administration uses seed monies as incentive for regional educators and specialists to develop revenue streams from their respective program

audiences and activities. Specialists and educators are also driven by the absence of internal support to sustain, via cost recovery, their programs from year to year. In addition, at the federal level, there are discussions proposing regional extension programming on a multi-state basis.

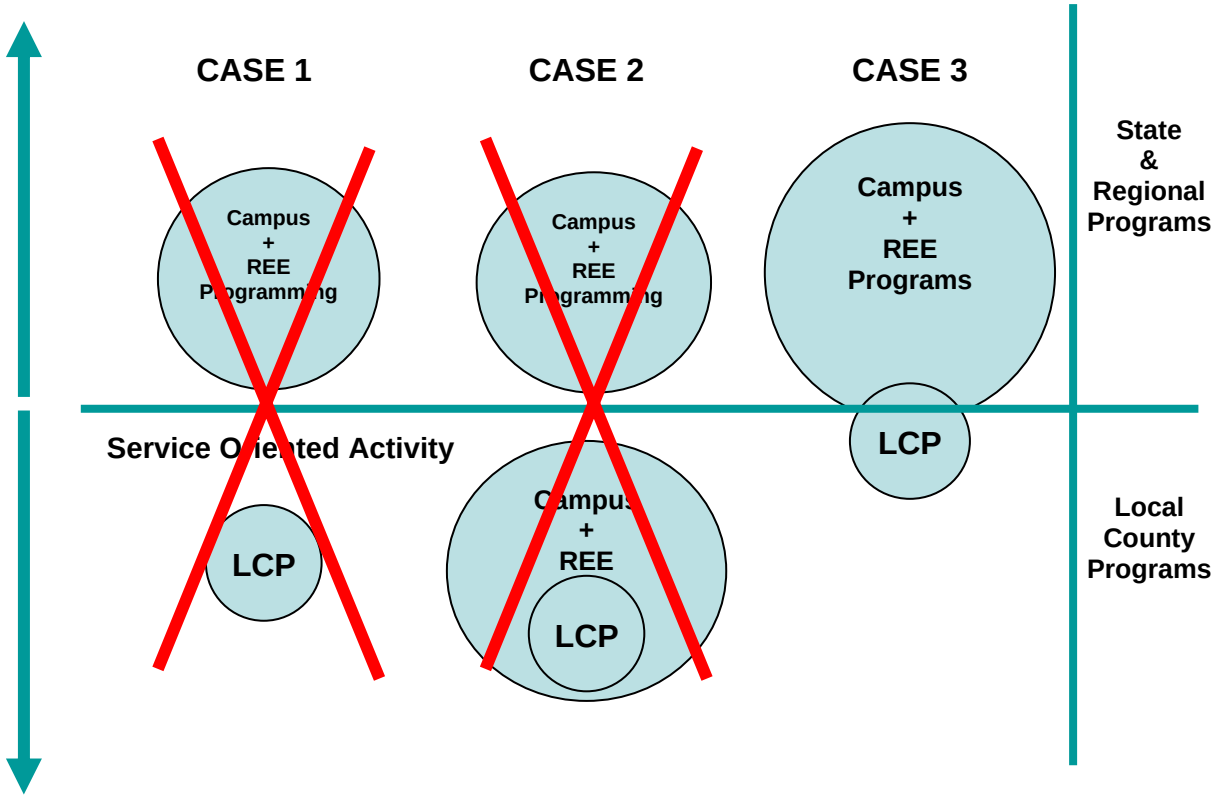

Diagram 3. Programming Oriented Activity

In spite of the strain of undergoing two reorganizations in as many years, we feel optimistic that the new regional programming alignment is the right direction for us to go with Extension programming in the future.

SWOT Analysis of the New Regional Extension Model

Strengths

- It is advantageous to directly align responsibility for extension livestock program and personnel with the DAS.
- There is more specialization within the programming teams.
- Livestock Extension program planning is now more focused across the state and integrated into local programming effort.
- Program business planning will bring clientele needs in closer alignment with program output.
- Program business planning will also sharpen program development by encouraging more thoughtful and complete program planning.

Weaknesses

- There are fewer livestock extension staff across the state to coordinate and promote programs.
- Programs with less income generating capacity could become perceived as "low priority" and eliminated. We will have to watch this carefully.

Opportunities

- The regional system provided an opportunity for increasing the livestock Extension programming capacity by adding 4 new livestock REEs to our staff.
- We were able to add an REE to focus on livestock manure systems education which is an issue of much concern in the state.
- If managed well, the regional model can provide the DAS with more visibility in the State.

Threats

- There are high expectations for the new system to succeed in improving program delivery in spite of a net decrease in Extension staff and funding. This may be unrealistic but, we do feel that the advantages of the regional system will enable us to be more efficient and more focused.

B. Future of Research and Outreach Centers

Background

The Department of Animal Science has seven tenured or tenure track faculty located at Research and Outreach Centers (ROCs). The administrative structure for ROC faculty has budgetary authority given through the ROC head, but tenure and promotion decisions are through the Department. This allows faculty at ROCs to be fully integrated members of the Department and fosters partnership with their peers. In addition to faculty located at the ROCs, a large number of Department faculty located on campus conduct field research and deliver educational programs at one or more of the ROCs. Historically, the focus of research and educational programs at ROCs has been on production agriculture, but this has been expanded in recent years to include environmental quality, ecology, economics, and community vitality. The ROCs play several key roles for the Department, College, and University and are an important resource for the future of the discipline.

Roles of Research and Outreach Centers

- The ROCs serve the entire University system as outdoor field laboratories for research and education. The ROCs are located such that they represent the geographic and climatic variability found in Minnesota and likewise are located in areas with diversity in agricultural production systems. As a result, the centers allow research and educational programs to address the unique needs of the various regions of the state.
- The presence of research faculty at ROCs facilitates intensive, long-term research. Research led by ROC faculty is most often done in cooperation with faculty from campus. Field research done at the ROCs allows for inclusion of the effects of both temporal and spatial scale, including systems level research.
- The ROCs serve as access points to the University of Minnesota for rural constituents, and are often referred to as the "Gateway" to the University. A wide variety of University outreach programs are offered at the ROCs. Locating researchers at the ROCs, while maintaining their integration in campus departments, has been a critical element for the University in understanding and addressing the needs of rural and agricultural communities.

- All of the ROCs have evolved as regional hubs, where a wide diversity of organizations link with the University. These organizations include commodity groups, state and federal agencies, watershed organizations, and non-governmental organizations.
- The co-location of faculty from different disciplines at ROCs promotes interdisciplinary, systems based research. For example, the dairy program at WCROC involves researchers in plant science, animal science, soil science, water quality, and economics. The same is true at SROC for dairy and swine, NCROC for beef and NWROC for dairy and beef. This, and other interdisciplinary research fostered at ROCs, has obtained national recognition.

Challenges

Recent budgetary reductions have resulted in more demand on the time of departmental and more specifically of ROC faculty to address the needs of traditional clientele, including agricultural producers, agricultural professionals, and state and local governmental agencies. These demands can be in the form of phone calls, office visits, and requests for participation in educational programs. There are many clientele needs, but few resources to address them.

Current trends in the University budget situation place increasing priority on tuition generation. This poses a challenge for the ROCs because they are physically distanced from the resident student population. Historically, ROC faculty members in DAS have not had teaching appointments. In addition to being off campus, teaching responsibilities for ROC faculty in their current roles would significantly dilute research and outreach educational efforts. However, in recent years we have been able to accommodate, albeit limited, the participation of ROC faculty in departmental teaching. To continue with this approach we will need adequate financial support for transportation and/or implementation of distance teaching. Resources at the ROCs can expand the experiences available to students in the Department and provide field laboratories not currently being used for teaching.

Potential losses of faculty threaten the vitality of ROCs. Individual ROCs have relatively small numbers of faculty, so losses of single positions have a large effect on the ability of the ROCs to accomplish their mission.

ROCs have relatively large infrastructure and human resource demands. Each of the ROCs requires equipment and staff to manage significant land areas and research programs in crop and/or livestock production. Facilities and equipment require upkeep, maintenance, and periodic replacement. Deterioration of facilities diminishes the ability of the ROCs to serve the University and the State. With reduced funds over the last several years, the ROCs have reorganized to keep core programs vibrant while addressing emerging issues. The goal of ROC faculty is to be indispensable to the College and the University by providing information vital to the citizens of the State and by being a visible example of the benefits the University brings to the State.

Future Directions

The ROCs will continue to be a vital resource to address many of the traditional research and educational needs related to agricultural production in general and to animal agricultural systems in particular. The NCROC houses a beef herd that is used for management and animal reproduction research. Investments have been made to develop an embryo collection and embryo transfer laboratory. The NWROC houses a dairy herd of about 100 production Holstein dairy cows where reproduction and nutritional physiological studies are being carried out. The NCROC has also a feedlot beef facility where approximately 400 steers are housed and used for nutritional studies. The WCROC is home to the alternative swine production and housing systems and the low input dairy production system. The SROC, on the other hand, is the home for the conventional swine production systems and the young stock dairy research unit. The ROCs are a vital part of the University system, facilitating multidisciplinary research within the Department and across the College and University.

The ROCs have and will continue to address emerging issues. The entire University can better address needs of rural and agricultural communities by fostering cooperation with ROC-based faculty.

Future efforts will include work on environmental quality, ecology, human health, and community vitality.

Faculty at the ROCs must continue to foster systems level research. For example, the ROCs have the potential to lead the Department in interdisciplinary research on animal waste to generate renewable energy.

In order to meet the increasingly complex demands of ROC faculty time by traditional and new clientele, a greater cooperation with Extension educators will be required. The best success with the newly organized Regional model of Extension will be achieved when efforts are made to cooperate with campus-based and ROC faculty.

C. Physiology/Growth Biology Discipline

The Physiology/Growth Biology discipline of the Department of Animal Science was formed in 1998 by combining the Physiology and Growth Biology disciplines, which were previously separate. This discipline now consists of 13 faculty (B. Crooker, Y. Da, B. Dayton, M. El Halawani, S. Fahrenkrug, D. Foster, M. Hathaway, C. Lamb, L. Mauro, S. O'Grady, A. Ponce de León, J. Wheaton, and M. White) with expertise in biochemistry, cell biology, molecular biology, reproductive physiology, nutritional physiology and genetics.

Current Status

Research

Research in the Department's Physiology/Growth Biology discipline focuses on identification and characterization of mechanisms that mediate the actions of regulatory factors on cellular processes such as proliferation, differentiation, metabolism, secretion, and intra- and intercellular communications in economically important species including beef, dairy, swine, poultry, horses, and sheep. Research in the Physiology/Growth Biology discipline supports DAS's research mission to "seek new knowledge about the biology, production, and care of domestic animals". Researchers in Physiology/Growth Biology are currently PIs on USDA Competitive Grants Program, NIH Grants, USDA/BARD Grants, and Industry grants/contracts totaling approximately 3.5 million dollars. The research strengths of the group are in three major program areas: Growth and Developmental Biology; Reproduction; and Genetics.

- **Growth and Developmental Biology:** Research in this area emphasizes elucidation of mechanisms regulating growth and development of muscle, bone and mammary tissues at the cellular and molecular levels. The roles of the pituitary and liver in growth are also being examined. Research projects utilize beef, dairy, swine and poultry as experimental animals. Additionally, where applicable, model systems from various laboratory animal species are utilized to answer questions relevant to animal agriculture. Specific research projects in this area include the following:
  - **Bone Growth and Development** (Yunker et al., 2004; Warmka et al., 2004)
    - Role of neuroendocrine signals during avian bone development and remodeling.
    - Mechanisms regulating the proliferation and differentiation of the bone-forming cells, the osteoblast.
    - Role of the bone microenvironment in supporting or suppressing the metastasis and secondary tumor growth of breast cancers.
  - **Cell Senescence and Immortality** (Himley et al., 1998; Kim et al., 2001)
    - Molecular biology of cell cycle genes.
    - Development of immortal cell lines from chicken, turkey, pig and human.
    - Virus propagation for vaccine production using immortal cell lines.
  - **Mammary Development** (Mammary Epithelial Cell (MEC) physiology)
    - Mechanisms and regulation of electrolyte transport in a human MEC cell line.
    - Role of senescent MEC in augmenting primary and tumor cell growth in culture.
    - Mechanisms regulating proliferation, differentiation, and secretion in bovine mammary epithelial cells (Lukas et al., 2003).

- **Muscle Growth and Differentiation**
  - Swine
    - Effects of Insulin-like Growth Factor Binding Protein-3 on muscle differentiation and proliferation – role in mediating myostatin action (Johnson et al., 1999; Kamanga-Sollo et al., 2003, Pampusch et al., 2003).
    - Effect of sub-therapeutic anti-microbial supplementation on serum insulin-like growth factor-1 and insulin-like growth factor binding protein levels in weanling pigs (Hathaway et al., 1999; Hathaway et al., 2003).
  - Beef
    - Mechanism by which anabolic steroids enhance muscle growth in feedlot steers (Johnson et al., 1998; Pampusch et al., 2003; Kamanga-Sollo et al., 2004).
- **Role of Liver and Pituitary in Regulation of Nutrient Use** (Crooker et al., 2001; Baumgard et al., 2002)
  - Cattle
    - Identification of mechanisms involved in regulating tissue and systemic response to physiological, endocrine, nutritional and genetic changes.

- **Reproduction:** Research in this area includes studies on the neuroendocrine control of reproduction in the turkey hen; reproductive endocrinology of cattle, sheep, and swine; and porcine endometrial epithelial cell physiology. Efforts are focused on methods to increase reproductive efficiency and to elucidate the interactive effects of nutrition, genetics and management. Specific research projects in this area include the following:
  - **Cattle and Sheep** (Lamb et al., 2001; Lamb, 2001; Wheaton and Godfrey, 2003)
    - Efficacy of embryo transfer
    - Development of breeding protocols to maximize fertility in lactating cattle
    - Altered physiology through use of BST and increased energy supply by supplemental dietary fat
    - Increase sperm production in rams and bulls
    - Increase ovulation rate in superovulated cows
    - Reduce the calving interval in beef heifers
  - **Equine** (Baily et al., 2002)
    - Biochemical factors in seminal plasma that increase fertility
  - **Pig**
    - Autocrine and steroid hormone regulation of electrolyte transport in an immortalized porcine endometrial epithelial cell line
  - **Turkey**
    - Characterization of neuroendocrine mechanisms regulating turkey hen reproduction
    - Light spectrum and the initiation of reproductive activity
- **Genetics:** Research in this area emphasizes the improvement of animal genetics by identifying and introducing genes for superior livestock performance. Statistical Genetics, Bioinformatics, Gene-expression analysis and Genomics are being used to identify superior germplasm in pigs and cattle. Statistical methods and computational tools for mapping genes underlying quantitative traits in domestic animals and mapping genes associated with health, reproductive and productive traits in dairy cattle are being developed. Functional genomics approaches are being used to generate large animals as models of human disease and as resources for medical products. Specific research projects in this area include the following:
  - Dairy QTL mapping with focus on mastitis
  - Modulation of livestock genomes
  - Microarray-based profiling of gene-expression in bovine and porcine tissues
  - Pig gene and QTL mapping with focus on medical traits (Fahrenkrug et al., 2002a, 2002b)

- Statistical methods, computational tools, and a relational database for gene mapping and genome annotation
- Structural genomics of the bovine Y-chromosome (Liu et al., 2002)

Teaching

The Physiology and Growth Biology discipline in DAS plays an important role in teaching and research within COAFES and CVM. Faculty in Animal Physiology/Growth Biology teach courses covering many areas of advanced animal biology including: animal physiology, animal reproduction, animal growth biology, biotechnology and environmental biology. These courses provide important disciplinary and interdisciplinary education for students in the Animal Science Major, CVM and many other Majors throughout the College and University. Many of the courses taught by the Animal Physiology/Growth Biology faculty group have recently been web-enhanced to allow web access to course materials to facilitate independent study and student learning. These courses continue to be updated annually to cover new scientific developments and issues of current interest. New web and instructional enhancements are continually being incorporated into courses to reach a broader population of learners with different preferred learning styles and to improve the students' understanding of physiological concepts. Courses taught by the Physiology/Growth Biology faculty fulfill the departmental teaching mission to "provide lifelong opportunities for people to learn about animal biology".

Focus areas in teaching include Advanced Animal Biology/Physiology, Reproduction, and Genetics. Courses taught in each of these focus areas are listed below.

- **Advanced Animal Biology/Physiology**
  - ScAg 1501 – Biotechnology, People and the Environment
  - AnSc 2301 – Systemic Physiology
  - AnSc 3202 – Environment, Global Food Production and the Citizen
  - AnSc 3501 – Principles of Farm Animal Environment
  - AnSc 3509 – Animal Biotechnology
  - AnSc 3511 – Animal Growth and Development
  - CVM 6130 – Veterinary Physiology
  - AnSc 8131 – Molecular Biology Techniques
  - AnSc 8211 – Animal Growth and Development
  - AnSc 8xxx – Current Topics in Hormone Action and Cell Signaling
- **Reproduction**
  - AnSc 3305 – Reproductive Biology in Health and Disease
  - AnSc 5327 – Endocrine and Reproductive Physiology
- **Genetics**
  - AnSc 5200 – Statistical Genetics and Genomics

Strengths of the Physiology/Growth Biology Section

A current strength of the Physiology/Growth Biology discipline is a critical mass of researchers with expertise in various areas of cellular physiology including regulation of gene expression, cell proliferation and differentiation, electrophysiology, hormone and growth factor action, and cell signaling. This expertise provides the capability to approach critical outcomes of animal agriculture (growth, reproduction and lactation) at the tissue, cellular, and molecular levels by utilizing cutting-edge research techniques such as yeast two-hybrid screening, siRNA, real-time rtPCR, gene transfer, microarrays, etc. Increased understanding of the cellular processes regulating critical outcomes in economically-important animals will fuel future advances in animal production. We believe the projects currently underway in the Physiology/Growth Biology discipline will elucidate specific aspects of these important cellular

processes; thus, these projects provide a viable framework for future research efforts. This belief is supported by the fact that many of these projects are funded by competitive grants from the USDA, NIH, and USDA/BARD.

Future Needs

Additional expertise in the area of cell signaling will complement the existing and future research and teaching efforts in cell physiology. As outlined in the Departmental Strategic Plan, the Physiology/Growth Biology group is committed to the development of this area of research because it will support studies that lead to elucidation of the mechanisms regulating cellular processes affecting economically important outcomes such as growth, lactation and reproduction of farm animals. In the most recent strategic plan, we requested two positions in the area of cell signaling. One faculty member with this expertise has been added within the last five years. The addition of a second faculty member in this area would provide the critical mass necessary to develop this new and unique area of research.

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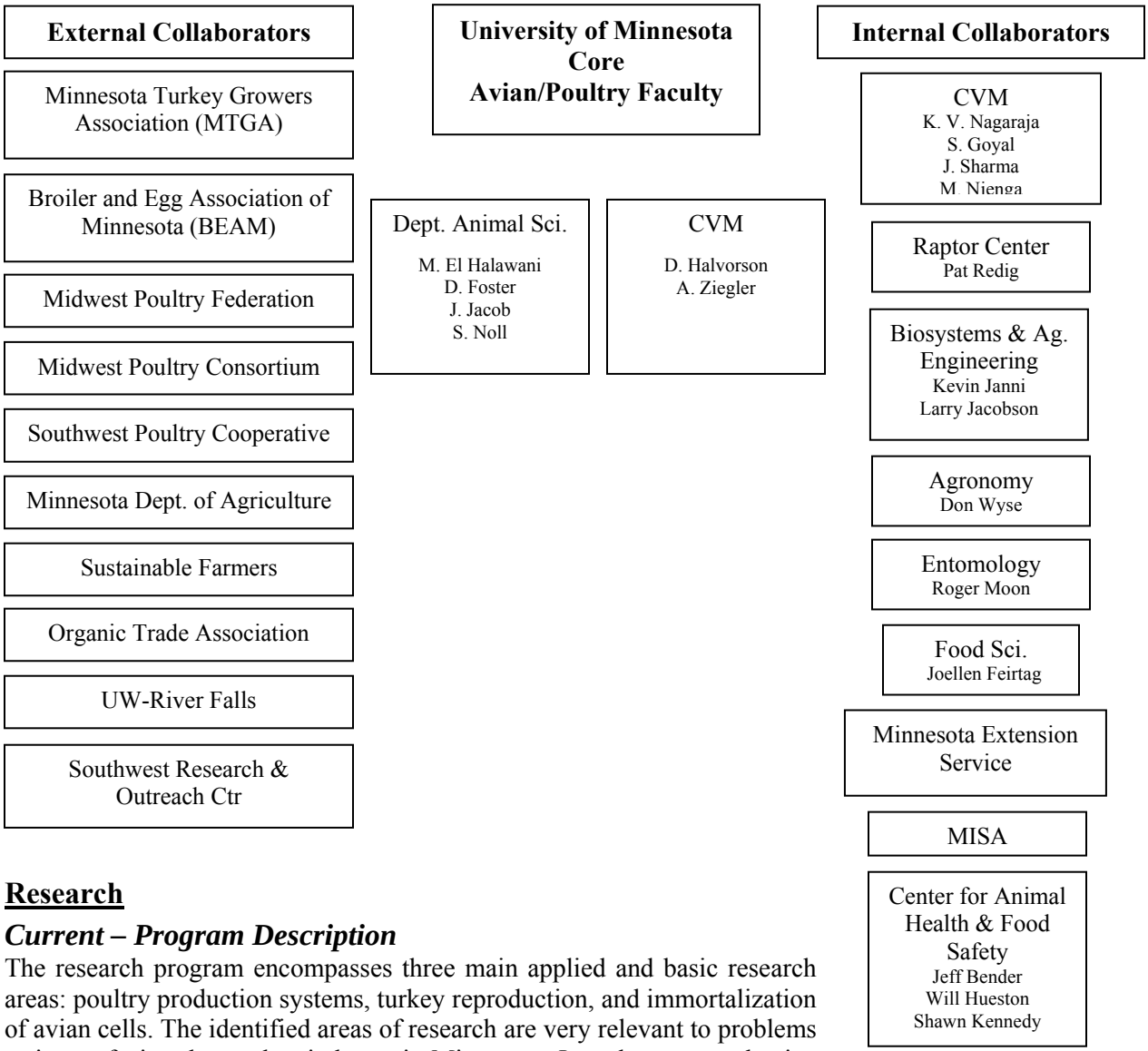
D. Animal Production Systems

1. Specialty Area Report: Avian/Poultry

Minnesota has significant poultry industries with the production of turkeys and table eggs ranked first and tenth in the nation, respectively. Minnesota is home to the largest turkey processor in the nation – Jennie-O Turkey Store. One broiler company (Gold N Plump) is based in Minnesota. In 2003, Minnesota raised 45 M turkeys, 44.8 M chicken broilers, and produced 2.96 B eggs from 11.2 M laying chickens. Within each of these industries, production is organized into hatching egg production, and commercial egg or meat production. In addition to commercial enterprises, the area of alternative poultry production is growing as well as an increased demand for consumer and youth programs. The diversity of the industry and audiences results in differing research, teaching, and extension needs. The core DAS avian/poultry faculty are: Mohamed El Halawani (17% Teaching, 78% Research); Doug Foster (50% Teaching, 50% Research); Jacquie Jacob (25% Teaching, 75% Extension); Sally Noll (60% Extension, 30% Research).

Collaborations extend across the university, research and outreach centers, and commodity groups as indicated in the following chart.



Research

Current – Program Description

The research program encompasses three main applied and basic research areas: poultry production systems, turkey reproduction, and immortalization of avian cells. The identified areas of research are very relevant to problems or issues facing the poultry industry in Minnesota. In turkeys, reproductive performance of turkey breeder hens is very poor in comparison to chicken

egg layers and hatching egg production is expensive. Introduction of avian pneumovirus in Minnesota in 1997 with its devastating effects, has led to research on various methods of control of which vaccination will be the most likely method of control. Management and nutrition of market poultry continues to impact performance with increasing implications for manure management, food safety and animal welfare. Dr. Jacob is the most recent hire in poultry (2001) and is implementing research in alternative poultry production systems.

Research Objectives

The objectives of the different research areas are:

- To investigate the neuroendocrine mechanisms underlying female turkey reproduction.
- To develop either lifespan extended or immortalized cell substrates for virus/vaccine production or model systems to elucidate mechanisms of avian cellular senescence and immortalization.
- In poultry production systems to: Develop feeding strategies for commercial and alternative production systems considering nutrient utilization and alternative ingredients; Determine influence of feeding, health and production practices on flock performance, nutritional quality and microbial safety of poultry meat and eggs.

Strengths

- A general strength of the program is the strong relationships that the poultry faculty has established with faculty in other colleges and departments, industry or producer groups, associations, and state agencies. The relationships assist faculty in broadening the scope of the projects, getting input from target audiences and assistance and coordination with state efforts. Some specific examples are:
  - Interdisciplinary research and extension program for pastured and organic poultry involves researchers from University of Minnesota including Matt Harbur (Agronomy and Plant Genetics, SWROC); Craig Sheaffer and Don Wyse (Agronomy and Plant Genetics); Roger Moon (Entomology), Jeff Bender (Center for Animal Health and Food Safety) and collaboration with Meg Moynihan, Kevin Elfering and Mary Hanks (Minnesota Department of Agriculture) and the SW Poultry Co-op.
  - Industry input and collaboration on ingredient evaluation including the Minnesota Turkey Growers Nutrition Subcommittee (composed of nutritionists), ethanol producers, Minnesota and National Corn Growers Association.
- Faculty have been successful in obtaining grants and gifts ($3.27 million in the last 5 years) from a wide variety of sources – commodity groups (Midwest Poultry Research Consortium, Minnesota Turkey Research and Promotion, Minnesota Corn Growers Association, Midwest Distillers Cooperative), internal (COAFES – Rapid Response Funds), federal (USDA-NRI; USDA/CSREES; BARD/USDA), and allied industry.
- Reputation for quality research is in high regard by the industry.
- Graduate students training in the area are recognized for the high quality research (J. Kalbfleisch and A. Al-Kahtane, Poultry Science Association – Certificates of Excellence; Shelly Christman received the UM Graduate Student of the year award for Ph.D. students in 2004; Byung-Whi Kong received both the Robert Shoffner and Ben Pomeroy awards (University of Minnesota) in 2003).
- Filing of patents (Foster – Two patents have been filed on the establishment of the TT-1 and SC-1 and SC-2 immortalized cell lines; El Halawani – VIP vaccination; Noll – Slaughter processing technology).

Accomplishments

The research conducted so far has resulted in the following relevant accomplishments:

- Characterization of the endocrine mechanisms underlying the initiation of incubation behavior (broodiness) in turkeys (El Halawani et al.1986; Youngren et al. 1991).
- Identification of the prolactin releasing factor in turkeys (vasoactive intestinal peptide, VIP) and characterization of the neuronal circuitry for its regulation (Mauro et al., 1989; El Halawani et al., 1990, You et al., 1995).
- Establishment that dopamine has both stimulatory and inhibitory influences on VIP/prolactin secretion as well as gonadotropin releasing hormone/gonadotropin secretion (Youngren et al., 1995).
- Vaccine development to immunize hens against VIP eliminated incubation behavior and increased egg production substantially (Ahn et al., 2001; El Halawani et al., 1995, 2000).
- Identification of the neuroendocrine neurons that become activated by light-induced reproductive activity (El Halawani et al., 2004).
- Demonstration that photostimulating breeder hen turkeys by the use of red (630nm) LED panel mounted lamps enhanced egg production.
- Isolation and culture of putative chicken embryonic stem cells – currently investigating what growth factors and media conditions will maintain a viable stem cell population without the use of heterologous feeder layers.
- Development of immortal turkey cell line- the world's first and only non-virally immortalized continuously growing turkey cell line (TT-1). This new turkey-specific cell line supports the propagation of avian pneumovirus (Kong et al., 2004).
- Development of immortal chicken avian cell lines – Establishment of two spontaneously immortalized chicken embryo fibroblast (CEF) cell lines (designated SC-1 and SC-2), only the second and third spontaneously immortalized, reverse transcriptase (RT)-negative chicken cell lines (Christman et al., 2004a, 2004b).
- Development of feeding recommendations for utilization of distiller dried grains in diets of market turkeys (Noll, 2003).
- Examination of protein and amino acids needs of market tom turkeys in an effort to reduce overfeeding of protein and subsequent manure nitrogen content (Waibel et al., 2002).
- Establishment of an infection model and pathogenesis of avian pneumovirus in turkeys (Jirjis et al., 2000 and 2002).

Vision

Future aspirations of the group include:

- In the organic poultry production area, Jacob is taking the lead in developing a national organic livestock group, which would coordinate research and outreach efforts on a national level. This group is looking at developing a multi-species system that incorporates additional livestock species into the system developed for pasture poultry production.
- Improve cooperative relationships with other faculty outside the UM to improve grant success.
- Work more closely with industry to improve funding level (identify value of research).
- Locate other productive sources of funding.

Future Direction

Reproduction - Future studies will be designed to utilize microarray technology, which will enable us to analyze gene expression globally within the bird's brain that has been subjected to changes in the environment, and that should give us glimpses for what collection of genes might be important for

successful response to environmental changes. In this way, we will be able to know where and when particular brain regions play a role in environmental response.

Poultry production systems - Examine poultry production practices and their relationship to welfare issues; and, develop production and care parameters for organic and pastured poultry systems leading to an economical and sustainable production system.

Challenges/Needs

- Lack of research feed mixing capability-this is being partially addressed with initial renovations of the existing mill at SROC-Waseca.
- Continuing decline and/or lack of maintenance in physical facilities.
- Budget cuts eroding internal support – especially in animal care positions, technicians, and graduate students.
- Expense of conducting applied animal research outpacing ability of commodity groups to support applied poultry research, especially that with turkeys, is expensive due to labor and facility needs, as well as feed costs.

Teaching

Current Program Description

Students interested in avian study or poultry production have some options. For poultry production, the Animal Science major gives students the option to obtain an emphasis in a species of choice. Students interested in poultry are to take poultry courses through the Midwest Poultry Consortium (MPC) Center of Excellence at UW- Madison. In addition, seniors can take the "Poultry Production Systems" course, which was re-introduced fall, 2003. Two MN faculty (Noll, Jacob) participate in the MPC program - assisting with the Poultry Nutrition Course and the Breeder/Hatchery Course. In addition, information about poultry is incorporated into multi-species courses such as Introduction to Animal Science and Animal Production Systems courses and the Avian Sampler Course. Avian information is also provided in other general courses such as biotechnology.

Faculty also participate in the teaching of other undergraduate and graduate courses – Systemic Physiology and Farm Animal Environment (El Halawani); Biotechnology (Foster); Introduction to Animal Science and Animal Production Systems (Jacob).

Dr. Jacob, who has been working with 4-H poultry program for 3 years, primarily conducts student recruitment efforts. One student will be starting in Fall '04 in the poultry management option and two more are expected for Fall '05. The new undergrads were all members of a state poultry judging team representing MN at the National Contest.

The objectives are to:

- Provide students with education and background regarding poultry production.
- Recruit students into the poultry science area for future jobs in the poultry industry or in the study of avian science.
- Continue to identify and incorporate poultry/avian science information into multi-species courses or in other teaching opportunities.

Courses

Poultry/avian courses (University of Minnesota)

AnSc 1021 Avian Sampler
AnSc 4605 Poultry Production Systems
AnSc 8xxx Avian Physiology
CVM Poultry Health Rotation
CVM 6880 Avian Core

Poultry/avian courses (Midwest Poultry Consortium (UW-Madison))
Animal Sciences 503 Avian Physiology
Animal Sciences 508 Poultry Products Technology
Animal Sciences 511 Breeder Flock and Hatchery Management
Animal Sciences 512 Avian Health
Animal Sciences 314 Poultry Nutrition
Animal Sciences 315 Poultry Enterprise Management

Courses - avian contributions (University of Minnesota)
AnSc 1101 Introduction to Animal Science
AnSc 1403 Companion Animal Nutrition and Care
AnSc 2301 Systemic Physiology
AnSc 3501 Principles of Farm Animal Environment
AnSc 3509 Animal Biotechnology
AnSc 4609 Animal Production Systems
CVM 6021 Overview of Animal Populations

Challenges
The faculty is motivated and enthusiastic about their field. The MPC program offers students tremendous opportunities with internships and a large number of participating faculty from Midwest universities. However, aside from the Avian Sampler course, enrollment has been low but numbers are starting to increase. A limitation at the graduate level has been the lack of a poultry nutrition course. An active poultry facility is lacking for use in teaching.

Vision
In the future, we would like to have more Poultry Science students with continuing recruitment efforts. Jacob has obtained a $3000 grant from the USPEA to take 4-H leaders to the International Poultry Expo to expose them to the extent of the job opportunities in the poultry industry. This will extend the recruiting efforts past campus and into 4-H. An active Gopher Poultry Science club would increase the visibility of the poultry option. The Gopher Poultry Science Club was started up again in 2003/2004 and is expected to increase it activity in 2004/2005. Incoming students have indicated an interest in starting up a collegiate poultry judging team at UM. Development of a poultry nutrition course – web based is needed to support graduate research in poultry.

Extension
Three faculty form the core of the poultry extension program titled "Poultry Production and Health". In Animal Science, Dr. Jacob and Noll have major extension appointments. The third faculty participant is Dr. David Halvorson in the avian health area. The *details* of the program are available in the *business plan* (2004). Briefly, the objectives of the program are:

- Reduce economic loss related to poultry disease, environmental factors, and stress
- Improve the nutritional value and safety of poultry and egg products
- Educate consumers and youth regarding poultry production and products
- Develop feeding strategies considering nutrient utilization and alternative ingredients

The poultry extension program offers education and information in a variety of methods – web-based; training workshops for industry ("poultry schools"), programs for youth and consumers, and cooperative industry programs. In addition current poultry extension faculty also participate and help support other outreach efforts including Minnesota Nutrition Conference, North Central Avian Disease Conference, Center for Animal Health and Food Safety, and MISA.

A highlight of the program has been the poultry schools. The first Poultry School was held in 1998 and emphasized Health of Laying Hens. Current offerings of Poultry Schools include: Chicken Layer

School I – Health of Chickens; Chicken Layer School II – Management of Laying Hens; Poultry Ventilation School; and Turkey School I – Health of Turkeys. The schools have been highly rated by participants and have high demand.

With the addition of Dr. Jacob to the group, UM has become quite active in youth/judging events. Her 4-H Poultry Judging CD-Rom has sold about 300 copies. It is an interactive, multimedia CD that provides 4-H members and leaders with virtual poultry judging practices. She has also introduced the state 4-H Chicken BBQ contest at the MN State Fair. Participation increased to 21 in 2003 with more expected in 2004. Dr. Jacob is actively involved in the MN State fair 4-H Poultry Show, especially with development of materials for the premier exhibitor event which includes a skill-athon, written exam and interview. She is also in involved in training MN representatives for the following contests - National Poultry Judging, Chicken and Turkey BBQ, Egg Preparation Demonstration and Avian Bowl.

Through the means described above, and in the business report, the program intends to improve the knowledge base of producers and consumers while assisting producers in improving management and safety of poultry products.

Challenges/Needs

- Lack of fertile egg flock for "Embryology in the Classroom" program. Currently looking at other alternatives.
- Lack of clerical/administrative support for the program within the department.

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2. Specialty Area Report: Beef

Current Status

Description

There are three core faculty on the Beef Team: Alfredo DiCostanzo, Cliff Lamb, and Deb Roeber. In total the group is invested as follows: 1.38 FTE in research, 1.37 FTE in extension, and 0.25 FTE in teaching. A summary of the contributions to research, teaching and extension are summarized on the following page.

Background and History

Historically, the DAS beef program had a strong focus on cow-calf and feedlot nutrition and management research and education. The late 1980s and early 1990s were times of tremendous change on the commitment and focus of the DAS to the Minnesota Beef Industry. Attrition by retirements, administrative appointments, and faculty departures decimated the original number of FTE from 5 FTE on campus and 4 FTE at the experiment stations to the current number of FTE. These changes in personnel led to changes in focus from nutrition and management of beef cattle to reproduction, nutrition and beef safety and quality. Although this may indicate a reduced focus of the team, it does reflect a policy of university administration not to duplicate efforts in times of reduced funding.

The Minnesota beef cattle industry contributes almost 1 billion dollars to the State's economy every year. In terms of economic importance, it ranks third after contributions of the dairy and swine industry of 1.3 and 1.2 billion dollars, respectively. Moreover, the Minnesota beef industry supports over 15,000 farms and numerous families who benefit directly or indirectly. Of all livestock industries in the State, the beef industry is the most diversified, including over 400,000 mother cows and over 300,000 cattle on feed. Nationally, Minnesota ranks in the top ten states for red meat production and cattle on feed. Minnesota's natural resources, land and water, support a strong grain and forage industry; both of which are vital to the beef cattle enterprise. Indeed, initiatives such as Minnesota AG 2010 support the utilization of grains by livestock within the State, instead of shipping unprocessed grain to other states for livestock feeding. In this realm, feeding Minnesota's 300,000 cattle on feed provides an outlet for over 20 million bushels of grain.

Within an industry context, the beef industry of Minnesota and the whole U.S. is undergoing rapid changes in response to consumer demands for a wholesome, high quality and consistent product. Other issues are the result of people's perceptions and changing attitudes toward rural issues—they stem from a perception of environmental exploitation by livestock producers. At the same time, the conditions under which beef cattle are raised are extremely diverse and, in many instances, small-scale producers account for the greater share of beef produced nationally. In Minnesota, 50% of the State's herd (about 200,000 cows) are kept on farms with 49 or fewer head. Issues facing these producers, whether small scale or not, center around increasing production efficiency to reduce the price of their product in the market place.

Within DAS and AES, only 3 FTEs are dedicated to beef activities. To place this figure in perspective, note that Minnesota ranks 9th in cattle feeding and 27th in cow-calf numbers in the nation. Two other states of similar ranking, Illinois (11th in cattle feeding and 26th in cow-calf numbers), and Indiana (13th in cattle feeding and 29th in cow-calf numbers) have 15 and 8 FTEs, respectively, dedicated to beef activities. Thus, given the size of the industry, Minnesota's investment in Department FTEs is three times smaller than that of IL or IN (176,250:1 vs 48,333:1 and 67,500:1 beef cattle:beef-dedicated FTE ratio for MN, IL or IN, respectively). Similarly, investments in infrastructure and beef cattle at ROCs by Minnesota are much smaller compared to those two states.

In spite of this disadvantage, faculty and staff at the University of Minnesota have been able to carve a niche in State and national beef research and education efforts. Limited resources that are allocated to beef activities have been dedicated to accelerating the transfer of research-based knowledge while focusing research on issues of importance to the industry.

Strengths

One of the main strengths of the Uof MN Beef Team is derived from the focus on the continuum represented by reproduction, nutrition and beef safety/quality. These three areas represent a large proportion of the beef industry's areas of concern. Research conducted in each of these three areas is readily applied, especially because each of the three faculty involved have a role in outreach. Due to the focus of the faculty involved, involvement in teaching is limited. This leads to reduced exposure by undergraduate students to the endeavors of the Beef Team, which results in limited opportunities to recruit undergraduate and graduate students.

Objectives

Research			**Extension**
Reproductive physiology	Nutrition	Beef quality and safety	To develop and implement economic and management strategies to enhance sustainability of beef farms
To improve reproductive efficiency through the use of embryo transfer	To optimize nutrient utilization for reduced environmental impact	To develop pre- and/or post-weaning management practices that enhance meat quality and safety	To create value-added opportunities for Minnesota cattle
To increase reproductive efficiency in beef cattle operations through twinning and estrous synchronization in	To evaluate alternative feeding and management practices to enhance profitability and sustainability of beef	To determine the value of pre-conditioning programs	To service Minnesota beef stakeholders and consumers via a beef education and information center—the
To determine the influence of diet and body composition on reproductive responses		To evaluate factors that predispose beef to greening of injection-site lesions	To enhance and sustain visibility between the Minnesota beef industry and the University of Minnesota.

The Beef Education Team is regionally, nationally, and internationally recognized as a premier source of information on issues related to reproductive management, feedlot and cow-calf nutrition, and beef quality and safety. Examples of this level of excellence are represented by the number of regional, national and international conferences and programs that members of the Beef Education Team are involved in. In support of these outreach efforts, there are three areas of prominence in research: embryo transfer and reproductive manipulation research generated at The Embryo Transfer and Reproductive Management Center at the NCROC in Grand Rapids, research in the use of use of polyclonal antibodies for growth promotion and health maintenance conducted in St. Paul and at the NWROC in Crookston, and research in pre- and post-harvest interventions to eliminate the risk of BSE transmission conducted in St. Paul and with partner institutions.

Competitive Advantage

In most universities across the US, Animal Science faculty teams are assembled by disciplines (reproduction, nutrition, meat science) rather than species groups. At the University of Minnesota, the three main faculty involved in beef contribute to strengthen each other's expertise within a species group. Other advantages of the group include the presence of an active and dynamic team structure (see Figure

1) which involves participation by Regional and County Extension Educators, faculty from other Departments and Colleges, and state departments, their cohesiveness, a tight working relationship, open communication, recognition by producers and industry groups, generating research that is immediately applicable, and having a working business plan in place. Disadvantages of the Beef Team stem from limited funding for graduate students, few experimental units for research (feedlot or drylot pens, and brood cows), and limited funding for human resources. Also because of low investment of FTEs in teaching, there is little or no relationship with the undergraduate program.

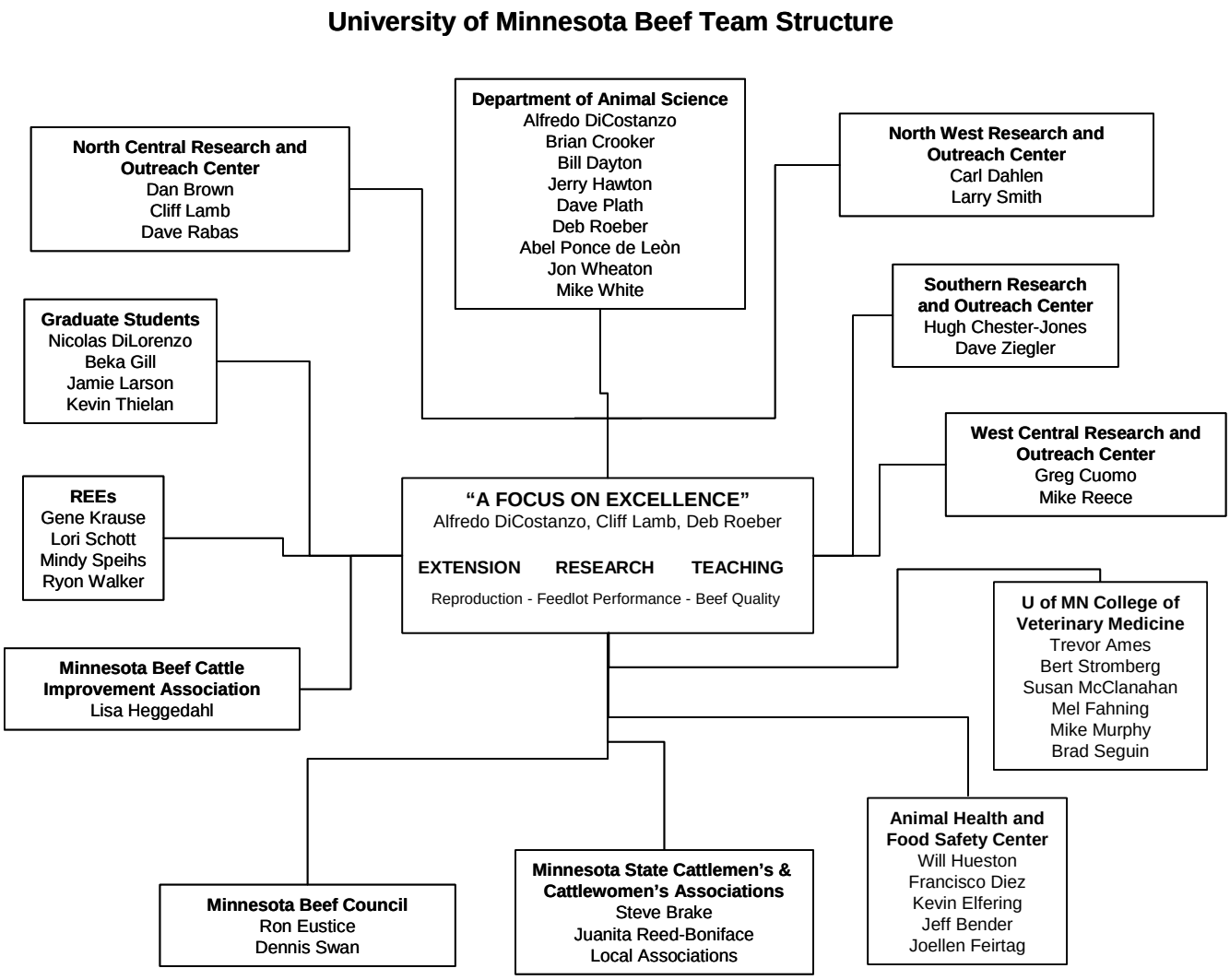

Figure 1. Schematic of the University of Minnesota Beef Team.

Relevance

The Beef Team is serving the mission of the department through constant contact with producers, industry organizations, and consumer on the quality, safety and wholesomeness of beef products and outlining for them ways by which reproduction and nutrition programs can help improve production systems. Specifically, Minnesota has gained notoriety for their beef program through high quality research and interactions with constituents in all areas of beef production and consumption, specifically food safety, embryo transfer, and use of alternative feeds and management practices to name a few.

The Future

Future Research Direction and Vision

The faculty core of the beef program have built a strong research and extension base by which producers and clientele across Minnesota have grown to trust and depend on. As such, we believe in strengthening their three areas of expertise: reproduction, feedlot management, and beef quality and safety. As the program continues to grow, we are dedicated to enhancing collaborations with the group outlined in Figure 1 as well as adding additional groups, associations and individuals that will benefit from our expertise.

Projected Areas of Importance; Knowledge Gaps; Opportunities for Research, Outreach and Funding; Opportunities in the Future

Areas of importance for the beef group are driven by the issues the beef industry is facing and/or technologies the industry are trying to perfect for use in the industry. As such, issues such as Bovine Spongiform Encephalopathy, food safety, and beef quality for example become opportunities for research, outreach and funding.

Factors Driving Research and Outreach

Two main things driving research and outreach – funding from industry/commodity groups and industry issues/challenges.

Partnerships and Stakeholders, Clientele and Funding Sources

The majority of current stakeholders and partnerships are outlined in Figure 1. In addition to the Minnesota clientele outlined in the figure, the Beef Program has also collaborated with the Iowa Corn Board, the National Cattlemen's Beef Association, Farm Bureau, industry related companies (pharmaceutical and feed companies), auction market organizations, and several universities.

Challenges

The biggest challenge facing the beef program is human resources and funding for those human resources (additional faculty, graduate students, animal attendants, lab workers, etc.) With limited funding and henceforth limited human resources the program will not be able to expand much beyond its current capacity.

Needs

Resources Needed

The Beef Team is concentrated in strengthening the three areas of focus. Over the next few years opportunities may exist to add human resources. While realizing that adding faculty is not an option (at least at the current time), the Beef Team would like to add graduate students and technicians. One way by which we can increase our visibility with the undergraduate program is through hiring a livestock judging coach who would also be a Ph.D. student in one of the three beef focus areas. This relationship would facilitate interaction with future and current undergraduate populations. Over the next few years, we would also like to enhance facilities and service at ROCs at Rosemount, Grand Rapids and Crookston. In Rosemount, we foresee increasing reproductive management research, adding grazing research in existing pastures that will be enhanced in 2004, and remodeling additional facilities in order to conduct the Carcass Merit Program on site. In Grand Rapids, through a grant applied to the Blandin Foundation, we foresee the expansion in reach of the Embryo Transfer and Reproductive Center where up to two additional technicians and/or post-doctorate associates will be required to handle the increased demand for reproductive procedures. Additionally, the reproductive herd and drylot capacity should be increased at least twofold to accommodate the needs of reproduction, nutrition and beef quality and safety research.

In Crookston expansion of existing feedlot capacity will enhance research to serve the needs of nutrition and beef quality and safety research.

Teaching

The core beef faculty are involved in teaching the following classes:

Courses Taught (last 5 years)

Designator	Name	Credits	% Effort	Term	Instructor(s)
VMED 8195	Pre-Harvest Food Safety and Public Health Aspects of Food Animal Production	1-3	20%	Spring	Roeber
Public Health Summer Institute	Global Beef Systems (2-day course)	0.5	33%	Summer	Roeber
VMED-Dairy	Dairy biosecurity		2 lectures	Spring	Roeber
VMED-Public Health	Pubic Health Rotation		1 lecture/ rotation	All	Roeber
ET Course	Bovine Embryo Transfer Course –UM/Crookston	1	100%	Spring	Lamb
Cow/Calf Rotation	Cow Herd Health and Production		25%	Spring	Lamb
ANSC 3305	Reproductive Biology		2 lectures	Fall	Lamb
ANSC 4603	Beef Production Systems Management		2 lecture /1 lab	Spring	Lamb
ANSC4403	Ruminant Nutrition	3	17%	Spring	DiCostanzo
ANSC4603	Beef Production Systems Management	4	80%	Spring	DiCostanzo
ANSC8311	Animal Bioenergetics	3	33%	Fall	DiCostanzo
ANSC4613	Advanced Beef Production Systems Mgmt	2	100%	Spring	DiCostanzo
ANSC8312	Protein Metabolism	4	33%	Fall	DiCostanzo

Undergraduate Student Senior Theses Advising (past 5 years)

Student	Year Completed	Advisor(s)
Dave Westlund	2000	DiCostanzo
Kris Seybold	In progress	DiCostanzo
Adam Kaiser	In progress	DiCostanzo

Graduate Students (past 5 years)

Student	Degree	Year Completed	Advisor(s)
Jim Cassady	M.S.	2000	DiCostanzo
Darren Standorf	M.S.	2000	DiCostanzo
Lance Miller	M.S.	2002	DiCostanzo
Chad Zehnder	Ph.D.	2003	DiCostanzo
Carl Dahlen	M.S.	2003	Lamb and DiCostanzo
Carl Dahlen	Ph.D.	in progress	Lamb and DiCostanzo
Jamie Larson	M.S.	2004	Lamb and DiCostanzo
Nicolas DiLorenzo	M.S.	in progress	DiCostanzo
Rebeka Gill	M.S.	in progress	Roeber
Kevin Thielen	M.S.	in progress	Lamb
Jamie Larson	Ph.D.	in progress	Lamb and DiCostanzo

Beef Extension

Please see Beef Team Extension Business Plan.

3. Specialty Area Report: Dairy Cattle

Background

Faculty Members

The dairy cattle group in DAS includes 13 faculty members at various locations, some with less than 100% effort directed toward dairy cattle. Three faculty members are based at ROCs: Dr. Hugh Chester-Jones, Waseca; Dr. Dennis Johnson, Morris; and Dr. Cliff Lamb, Grand Rapids. Drs. Chester-Jones and Johnson work predominantly with dairy cattle, whereas Dr. Lamb emphasizes beef cattle, but also conducts research in dairy cattle reproduction. Dr. Hans Jung is a forage specialist with USDA-ARS, and he is housed in the Department of Agronomy and Plant Genetics. Dr. Abel Ponce de León is Department Head, but he has continued some ongoing research.

The remaining eight faculty members are housed in Haecker Hall on campus. Three have a majority appointment in extension (Marcia Endres, Jim Linn, Jeff Reneau), three have a majority appointment in teaching (Les Hansen, Tony Seykora, Marshall Stern), and two have a majority appointment in research (Brian Crooker and Yang Da). The contributions of Drs. Endres, Hansen, Linn, Reneau, and Seykora revolve completely around dairy cattle. Drs. Crooker and Stern lean heavily toward dairy cattle, but their research is basic in nature and, in some situations, applies to ruminants other than dairy cattle. Also, Dr. Stern teaches a popular companion animal course. Dr. Da's mathematical modeling for genomics research is for pigs as well as dairy cattle. Consequently, about 10 FTE of faculty are involved in the dairy cattle group across locations.

Impact on Dairying in Minnesota

Traditionally, the dairy group has been highly visible on the national and international scene in teaching, research, extension, and service. However, the state of Minnesota has continued to fall in relative ranking for milk production among leading milk producing states, and currently is ranked 6th. The chicken, turkey, and swine production industries have largely completed a conversion to larger and more specialized production systems, and the future impact of those species for Minnesota agriculture might be somewhat clearer than is the future of dairying.

The dairy group has historically been "in touch" with producers in the state. However, some Minnesota dairy producers are resistant to change, many of the state's dairy facilities are in poor condition, and the potential role of alternative production systems needs to be explored.

The dairy cattle group's effectiveness has been hampered by two key factors:

- Difficulty getting dairy industry (all levels) to rally may be part of the "Minnesota Nice" syndrome.
- Dairy constituents are too content with the status quo – this tendency applies to almost all segments associated with the Minnesota dairy industry.

Strengths of the Dairy Group

- Undergraduate dairy science program is responsive to student needs and is recognized among the top five in the country – Gopher Dairy Club has approximately 100 members.
- Outstanding faculty, who are recognized for meeting the needs of the dairy industry.
- Strong collaborations with dairy producer groups and MN Department of Agriculture.
- Current research programs emphasize unique applied topics that have drawn national attention, including youngstock, low-input production systems, and crossbreeding.
- A teaching/research dairy facility with cows and calves is maintained on campus.
- Strong ties and programmatic efforts with CVM faculty.
- Recognized for providing ongoing service to professional societies, especially the American Dairy Science Association.
- Generally speaking, the group has a positive team spirit.

Competitive Advantages Compared to Other Dairy Cattle Groups Nationally

- Twin Cities area offers a wonderful variety of cultural and recreational opportunities.
- Research is possible with dairy cattle at the ROCs in addition to campus dairy facility.
- Strength of allied industries for dairy cattle in the vicinity.
- Dairy industry in Minnesota is poised for revitalization.

Concerns of the Dairy Group

- Teaching and service demands diminish contributions in research and extension.
- Disappointing publication rate in scientific journals during recent years (directly related to increased demands on time of the group for teaching and service).

Goals of the Dairy Cattle Group

Teaching of Dairy Students

- Actively recruit undergraduate students that have interest in dairy cattle.
- Successfully impart knowledge to undergraduate students, who have divergent career paths including: hands-on management of herds of dairy cows, service positions with support companies, advanced degrees in dairy science, and leadership positions in the dairy industry.
- Provide a valuable learning community on campus through the Gopher Dairy Club, the North American Dairy Challenge, and the Intercollegiate Dairy Cattle Judging.

Research of Dairy Cattle

- Energetically address emerging topics that impact Minnesota milk production, which currently include management systems, reproduction, and the environment.
- Conduct basic research that is appropriate for potential needs of the dairy industry.
- Achieve complementarity with teaching and extension programs for programmatic efficiency.

Extension Activities

- Assist in the revitalization of the Minnesota dairy sector
- Transfer knowledge on personnel management and environmental impact
- Improve the profitability of dairies, regardless of type of production system

Graduate Students, Post-doctoral Scientists, and Laboratory Scientists

The dairy group currently has 10 graduate students (eight M.S. and two Ph.D.). The dairy group also has one post doc, one laboratory scientist, and one information tech professional.

Applied Nutrition (Linn, Johnson)

Three graduate students (one also serves as an assistant scientist).

Basic Nutrition (Crooker, Stern)

Three graduate students and one laboratory scientist.

Genetics (Da, Hansen, Seykora)

Two graduate students, one post doc, and one information tech professional.

Management (Endres, Reneau)
Two graduate students

Specific Expertise of Faculty Members

Nutrition
Dr. Stern's primary research objective has been to develop methods for enhancing efficiency of protein utilization by dairy cattle. Effort has included: analysis of animal byproducts and protected plant proteins as sources of supplemental protein for ruminants; influence of direct-fed microbial additives on rumen microbial fermentation and populations; interaction of carbohydrate and protein source on intestinal protein supply; evaluation of diaminopimelic acid, purines, and nitrogen-15 as markers for microbial synthesis in vivo and in dual flow continuous culture fermenters; development and use of an in situ/in vitro multi-enzyme (three-step) procedure for estimating intestinal digestion of dietary protein; characterization of ruminal microbial ecology using continuous culture and ribosomal RNA-targeted probes to monitor microbial populations; preparation of lactating cows with a subcutaneously elevated carotid artery and indwelling catheters in the hepatic, portal and two mesenteric veins to study the effects of methionine supplementation on amino acid metabolism; impact of mycotoxins (patulin) on fermentation by ruminal microorganisms; and development of near infrared reflectance spectroscopy (NIRS) equations for predicting ruminal protein degradation and intestinal protein digestion of forages (Bach et al., 2000, Ziemer et al., 2000).

The research of Dr. Stern has directly impacted ruminant feeding programs and has provided valuable contributions to the understanding of carbohydrate fermentation and protein degradation in the rumen, and digestion of protein in the small intestine.

The goal of Dr. Crooker's research is to improve understanding of the physiological controls that regulate nutrient utilization and lactational performance of dairy cattle. This research involves the manipulation of animal physiology by metabolic modifiers, genetic selection, and nutrient availability to identify mechanisms that affect nutrient utilization and efficiency of animal production. He has been involved in a number of studies that have investigated effects of new animal pharmaceuticals on growth and lactation. He has investigated effects of selection for milk yield on genetic polymorphisms, hepatic and pituitary gene expression, and response to metabolic or physiological challenges (Baumgard et al., 2002).

Dr. Crooker's research has enhanced current understanding of: the ability of intramammary infusions of prostaglandin E_2 to increase intramammary development and milk yield of cows induced to lactate, the characterization of effects of milk yield on endocrine profiles, the hepatic genetic expression of lactating cows and growing calves during nutrient and energy deficit, and the pituitary somatotropin response to somatotropin releasing factor in low and high milk cows (Crooker et al., 2001; Lucy and Crooker et al., 2001).

Drs. Chester-Jones, Johnson, Jung, and Linn work in research teams to address a range of topics related to the applied nutritional needs of dairy cattle. Corn silage studies have determined the effect of hybrid variety on lactational performance. Research has been conducted on the development of alfalfa and corn stem tissues, selection of alfalfa lines for improved fiber digestibility, on the determination of impact of differences of digestibility of fiber among alfalfa hays, and on the identification of targets for plant genetic manipulation that will result in higher quality forages. (Moncrief et al., 1999)

The impact on metabolic problems and milk yield of multiple feed additives in dairy cow diets pre-partum and drenching with either propylene glycol or multi-additive mix during the first three days post-partum has been studied. The feeding of 100% chelated polysaccharide mineral complex to dairy cows at recommended levels has been explored. Calf studies have looked at accelerated growth programs with milk replacers and the evaluation of calf starter rations (Hoffman et al., 2001).

Grazing and forage quality of pasture is emphasized at the Morris ROC. Several studies of pasture management and ecology have been conducted, including rotational grazing of mixed plant species. The grazing program has examined pasture renovation systems, evaluation of forages for grazing, seasonality of calving, and group rearing of calves. Research at Morris is based on the need to identify reduced input

systems that are effective for medium-sized dairy farms. The current objective at Morris is to conduct a 5-year study comparing conventional dairy management with a reduced-input dairy production system focused on seasonal production, intensive grazing, crossbreeding for hardiness, outdoor packed bedding, and value-added systems (Cuomo et al., 1999).

Growing dairy heifers are now the focus at the Waseca ROC. A lactating herd of Holstein cows at Waseca was eliminated in 2003, and new facilities for heifers were constructed. A unique partnership with industry and dairy producers provided financial assistance to permit the construction of the new facilities. An industry partner for heifer research is contracted for the next five years. There will now be a sufficient number of heifers grown at Waseca to provide adequate experimental units to allow for good statistical power of test for numerous applied studies related to nutrition and management of growing heifers (Chester-Jones et al., 2003).

Extension programming in nutrition emphasizes problem solving and includes: feeding management schools, calf management workshops, water quality, feed intake of dairy cows, energy systems of the 2001 dairy NRC, maximizing corn silage in diets, forage quality for dairy cows, forage grazing management, pasture walks, and transition cow management (Linn, 2001a, 2001b, 2002, 2003).

Genetics

Dr. Da, with Dr. Hansen as a collaborator, has a goal to develop a genomic approach for genetic selection of dairy cattle to improve mastitis resistance and fertility. Specific objectives are: 1) to generate a QTL mapping population with 360 half-sib backcross offspring using a 1964 "control line" × "current genetic line" cross of Holsteins, and 2) to conduct a genome scan using 400 genetic markers on the mapping population to find QTLs affecting numerous traits of dairy cattle, including SCS. Embryos (380) have been collected from the crossing of the 1964 control-line cows with six "contemporary" Holstein sires that are inferior for mastitis (Da et al 2000; Da, 2003).

The majority of Dr. Da's research involves mathematical modeling for marker-assisted selection. A two-step mixed model method combining marker and phenotypic information was developed for genetic evaluation. Computer simulations show that marker-assisted selection should improve selection accuracy, particularly when traditional phenotypic selection is least effective, i.e., when heritability is low and the percentage of selected individuals is high (Da et al., 1999; Da et al., 2002; London et al., 2003).

Dr. Ponce de León studies the structural and functional organization of the bovine genome, focusing on the construction of a bovine Y-chromosome (BTAY) physical map. The absence of recombination at meiosis, the abundance of Y-specific repetitive sequences, the tendency of its genes to degenerate during evolution, and the functional coherence of its gene content in male growth, spermatogenesis and fertility are some of the characteristics that make the Y-chromosome unique. Although physical mapping of the Y-chromosome is difficult, progress has been made in constructing an initial physical map for BTAY. A significant amount of the information regarding gene structure and order on BTAY has been reported, particularly in the areas of BTAY microsatellite (MS) and sequence-tagged site (STS) development, Radiation Hybrid (RH) mapping, BAC fingerprinting and contig development, and Y gene cloning. These efforts provide an initial platform on which to complete the characterization of BTAY and provide a robust, comparative, fine map of its structure in lieu of the unlikely future sequencing of this chromosome (Liu et al., 2002).

Drs. Hansen and Seykora are quantitative geneticists with close ties to the applied dairy breeding industry. Non-production traits have been the focus of research over time, and Seykora collaborated with USDA to revise the national Net Merit selection index, which involved incorporating additional traits and altering the weights placed on traits previously in the index. The new index was adopted for the August 2003 national ranking of dairy cattle in the U.S. Furthermore, results from Dr. Hansen's long-term body size selection study at the Crookston research center resulted in an appropriate negative weight on body size in the Net Merit index (Van Randen and Seykora, 2003; Hansen, 1999).

Most of the research of Drs. Hansen and Seykora currently revolves around crossbreeding of dairy cattle. Crossbreeding might help to alleviate the reproductive failure and health decline of dairy cows in recent years. Seven cooperating dairies in California have been crossbreeding Holsteins with sires from European breeds – Normande and Montbeliarde from France, Swedish Red, and Norwegian Red. The

crossbreds in these California herds are similar to pure Holsteins for production, but the crossbreds have significant advantages over pure Holsteins for stillbirth, calving ease, cow fertility, and cow survival. Furthermore, a crossbreeding system has been implemented for cows in the St. Paul dairy barn and Morris ROC. The system included three breeds – Jersey and Montbeliarde, in addition to Holstein. The University of Minnesota was the first to begin studies with crossbred dairy cattle. There have been an incredibly large number of requests for results of the crossbreeding research via extension programming (Hansen, 2000; 2003; Sonnek et al., 2001).

Reproduction/Management

Because pregnancy rates of lactating dairy cows have continued to decrease and insufficient reproductive performance is a growing concern for dairy producers, Dr. Lamb recognizes the issue of poor reproductive efficiency of dairy cows involves a combination of biological and management factors. Therefore, Dr. Lamb plans to focus on three areas of dairy research at the Crookston ROC: 1) the development of breeding protocols to maximize fertility in lactating cattle with special emphasis on anovulatory or anestrous cattle, 2) the efficacy of using the CIDR to enhance pregnancy rates at a synchronized breeding in cattle and to resynchronize the first eligible estrus in non-pregnant cows after a previous insemination, and 3) the effects of transferring sexed whole, half, or quarter embryos into estrous synchronized dairy heifers on pregnancy rates, and subsequent female:male ratio of calves (Arthington et al., 2003; Lamb, 2001; Lamb et al., 2001; Spell et al., 2001; Lamb et al., 2000).

Dr. Reneau has provided the leadership for "Quality Count$", which is a collaborative statewide SCC reduction effort between the University of Minnesota, Minnesota Department of Agriculture, and all dairy processors. The goal of the program is to reduce the average bulk tank SCC in Minnesota to below 300,000 by June 2005. The Minnesota Commissioner of Agriculture initiated the program because Minnesota had the poorest quality milk among the top ten dairy states. Reneau led the development and delivery of the SCC reduction educational program. Collaborators in the Department of Animal Science and Minnesota Extension Service were involved in numerous educational activities. Current trends suggest that Minnesota is making excellent progress in lowering SCC (Reneau et al., 2004; Reneau and Kinsel, 2001; Reneau, 2000).

Dr. Endres has a broad range of research activity related to dairy cattle management, including the assessment of risk factors for lameness in dairy cows, the relationship of cow hygiene scores and somatic cell counts, the correlation between milk production and lameness, the effect of feed barrier design on social and feeding behavior of loose housed dairy cows, the effect of sand or dolomitic limestone bedding on cow comfort, and the yield and feeding value of annual crops planted for emergency forage. Her extension activities include serving as dairy modernization program team leader, coordinator of the dairy cow comfort and behavior extension curriculum, member of subcommittee developing new curriculum on "successful dairy systems – options for dairy families at the crossroads", the presentation of training workshops for milkers in Spanish, the coordinator for Minnesota Dairy Days, and coach of the North American Intercollegiate Dairy Challenge for undergraduate students (Clanton et al., 2004; Endres, 2003a, 2003b).

Future

Vision – Aspirations of the group for the future

- Become the #1 rated undergraduate dairy science program in the country.
- Development of the UMore Park Dairy Facility at Rosemount is essential for research.
- Build even stronger ties with dairy producer networks and industry partners.

Focus for Future Research

The dairy cattle group has fleshed out three areas of focus for future research:

- Youngstock
- Genetics
- Reproduction

However, management is an overarching theme across these areas of focus, and nutrition is an important factor for any management system. The focus areas for research areas have demonstrated need, and they are research areas in which current scientific expertise exists.

Needs

- Based on the needs of dairy producers in Minnesota and the declared areas of research focus for the future, there is **need for an additional reproduction specialist** within the dairy group. Other faculty positions would be welcome, but the key need at this time is in reproduction.
- **Too few graduate students and inadequate funding** to support graduate students.
- Lack **dairy facilities for research with groups of cows**; therefore, the new dairy facility at UMore Park in Rosemount is essential.
- **Insufficient financial support for existing** teaching/research **dairy facilities** on campus and at the ROC research dairy facilities.
- **Inadequate** financial support for **technical support for research**.

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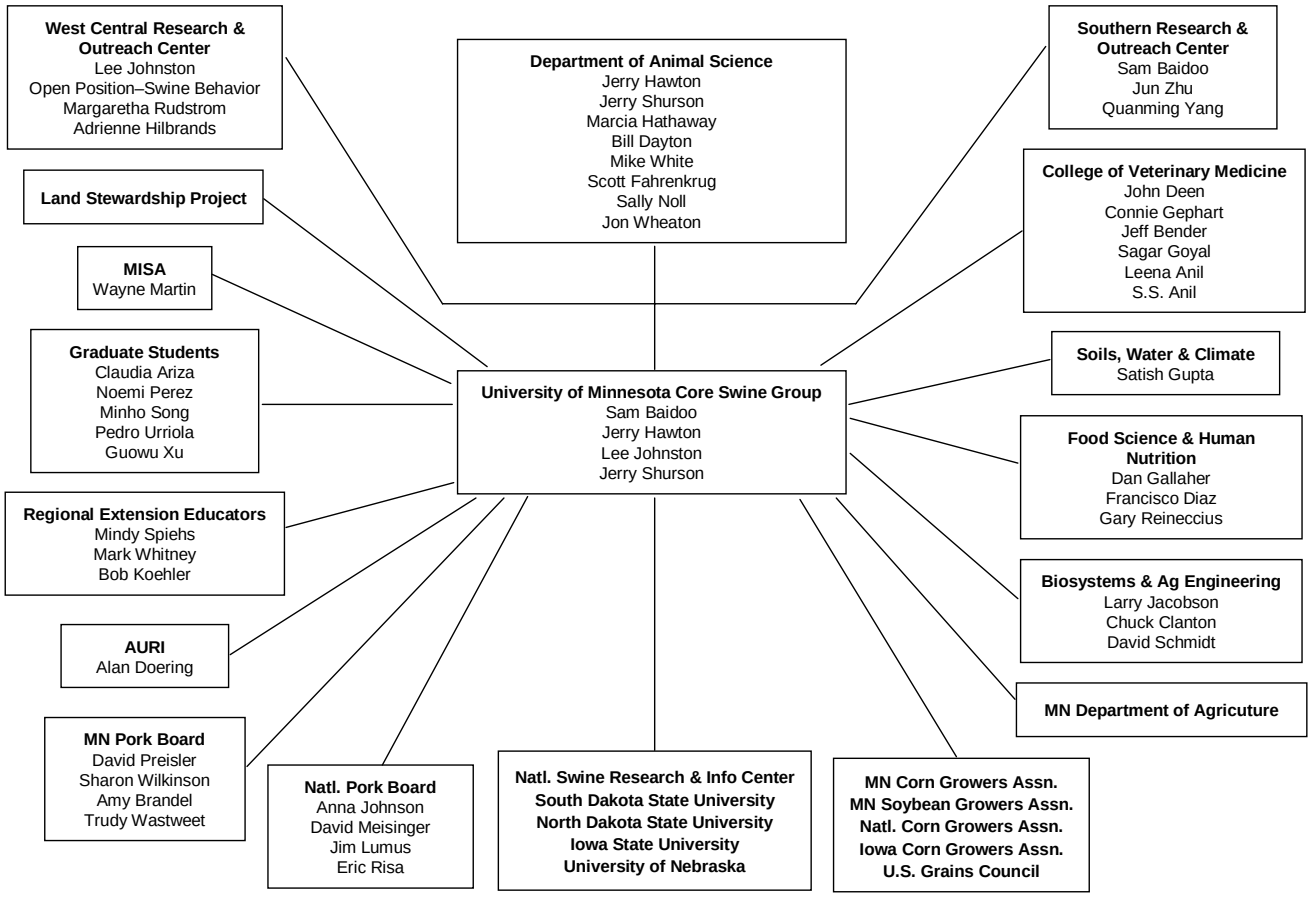
4. Specialty Area Report: Swine

Current Status

Background

Our core swine group consists of Sam Baidoo, Jerry Hawton, Lee Johnston, and Jerry Shurson. Our specialization is applied swine nutrition, but we are also actively involved in pork production systems management. We collaborate with several other faculty within the Department, ROCs, COAFES, CVM, as well as with several external groups as shown in Figure 1. We have an excellent reputation in the feed and pork industry, as well as with several commodity groups, for conducting sound, relevant research, and being effective educators. As a result, we continue to be successful in acquiring a significant amount of industry funding for our research and educational programs. We also have an excellent reputation for training outstanding undergraduate and graduate students.

Figure 1. University of Minnesota Swine Group Collaborators



History

Historically, our group has been known for cutting edge research in sow nutrition (Johnston et al., 2003) with emphasis on the role of nutrition in support of reproduction (Yang et al., 2000a, 2000b, 2000c). As a result, this has allowed us to be successful in obtaining state funding support for the construction of a relatively large, new sow research facility at SROC, and alternative swine housing facilities at WCROC. However, our research program continues to be focused on additional research areas to find solutions for current and emerging issues in the U.S. pork industry which include:

- The role of nutrition in reducing odor and gas emissions and nutrient excretion from swine manure (Baidoo et al., 2003; Knott et al., 2001; Whitney et al., 2001).
- Evaluation of the nutritional value and potential value added properties of distiller's dried grains with solubles (Spiehs et al., 2002; Whitney et al., 2003; Shurson et al., 2004).
- Evaluation of alternative swine housing systems and nutrition, and their impact on animal well-being (Leena et al., 2003).

The recent construction of new swine facilities at SROC and WCROC has provided us with excellent resources for our research and outreach programs. Availability of large numbers of pigs is very good. Due to limited laboratory space, equipment, and laboratory technicians, we utilize laboratory facilities managed by other faculty in DAS, laboratories of other departments at the U of MN, commercial laboratories, and laboratories at collaborating ARS and universities to meet most of these needs. Our graduate student program has been, and hopefully will continue to be the "glue" that has enabled our group to function so well as a team. We have been active, long-term participants in NCR-42 (Swine Nutrition-Baidoo/Shurson) and NCR-89 (Swine Management - Johnston) regional committees, as well as the National Pork Board's Swine Educators Committee (Johnston/Shurson). The quality of our on-campus swine teaching program has been highly regarded, but student enrollment in these courses has been declining in recent years.

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Strengths

- Internationally recognized programs.
- New swine facilities (SROC and WCROC).
- Cooperative relationships within the core swine group.
- Very good working relationship with feed and swine industry, and commodity organizations.
- Graduate students are highly sought after upon graduation.
- Increasing international component of our research/outreach activities.

Relevance

Because we are addressing critical issues in the swine industry (effect of nutrition on odor and manure management and swine behavior and housing systems), we have been successful in obtaining a significant amount of funding for our research program from both industry and commodity organizations. The rapid growth of the fuel ethanol industry in the U.S., and the need for research and education related to the large amounts of the by-product (distiller's dried grains with solubles) being produced, has also allowed us to obtain a significant amount of research funding from industry and commodity commodity groups and has allowed us to become an internationally recognized, leading authority in this area. However, depending on the final outcome of legality of mandatory commodity checkoff programs, funding resources available to sustain some of these programs may be drastically reduced.

Future

Future Research Directions

Due to the relevance of our research and educational programs, and the high demand for our expertise in our current research program areas, we will continue our focus in these areas. We are, and will continue to develop research, outreach and teaching collaborations with other regional swine programs to improve productivity while conserving limited resources. With the hiring of new Regional Extension Educators with swine responsibilities, we will now have the capabilities of building a stronger swine extension program but also enhance our applied research program through their involvement. Dr. Johnston's one year sabbatical leave will also allow him to bring new ideas and approaches that will complement our existing efforts.

Vision

Our vision is to continue to conduct scientifically sound and relevant research to help solve significant pork industry problems, provide innovative teaching and outreach programs to improve the knowledge base of pork producers, educators, agribusiness professionals, and non-farm audiences in swine nutrition and pork production systems, and train outstanding students.

Projected Areas of Importance

We have been actively involved in developing and implementing innovative programs in the pork industry such as the Minnesota Certified Pork pilot program and working closely with MDA to continue to develop opportunities and applications for the Minnesota Certified program (e.g. Minnesota Certified Distiller's Dried Grains with Solubles). With the increasing need to improve pre-harvest food safety, reduce dependence on subtherapeutic use of antimicrobials in pork production, improve animal housing, handling and transport, and traceability throughout the food chain, and reduce gas and odor emissions as well as manure nutrient excretion, our program may also evolve into one or more of these research and education areas of importance. Our program will evolve into the area of swine behavior/welfare with the addition of a new faculty member at WCROC.

Opportunities in the Future

We have a good working relationship with swine colleagues at several other neighboring universities and will continue to build stronger collaborative research, extension, and teaching programs. We have, and will continue to develop long-term research agreements with feed industry groups (e.g. GAP, Big Gain, Cargill, Omega Nutrition) to collaborate on research topics of mutual interest. We are also exploring long-term arrangements to obtain funding for graduate students through other feed industry groups (Land O'Lakes and Zinpro Corp.). The swine welfare/housing work may be fundable through non-traditional sources for our group such as foundations, humane farming groups, etc.

Factors Driving Research and Outreach

- Industry and commodity group funding.
- Relevance to industry issues.

Partnerships and Stakeholders, Clientele and Funding Sources

See Figure 1. (University of Minnesota Swine Group Collaborators).

Knowledge Gaps, Opportunities for Research, Outreach and Funding

See "Projected Areas of Importance and Opportunities in the Future" (above).

Challenges

- Financial support for graduate student research assistantships
- Financial support for farm animal attendants
- Financial support for on-campus Research Fellow
- Since swine facilities/herds are expensive to maintain and operate, it is a challenge to keep convincing administrators that they need to continue supporting the operation of university swine units.

Needs

Resources Needed to Support Future Growth

Faculty positions

Swine reproductive physiology; meat scientist with emphasis in pork quality and safety.

Support personnel and students

Availability of adequate farm animal attendants at SROC and WCROC has been a significant detriment to our program. DAS administration has provided funding for the last 3 years for a scientist position to support our research. Unfortunately, recent Departmental budget cuts have caused elimination of a Research fellow position on campus which will have a significant effect on our ability to effectively coordinate numerous research, outreach and education activities among graduate students and faculty within our group. With the loss of Departmental Research Assistantships, it is much more difficult to recruit top quality graduate students due to long-term funding uncertainty and be as productive and effective as we have been historically. Maintaining a critical mass of graduate students in our program will be essential for our future success. Our typical funding sources are hesitant to provide long-term funding for graduate students.

Analytical facilities

As long as we have access to the laboratory facilities and analytical equipment on campus and with collaborators which we have been fortunate to have in the past, we can continue very successfully using others resources in the future.

Infrastructure support

Our current infrastructure is very functional and will be enhanced with the addition of recent REE hires and the filling of the swine behavior/welfare position at WCROC. However, unless we can find solutions to obtaining the necessary resources described in B., we will have difficulty maintaining the current productivity and visibility of our programs.

Teaching

The core swine group plays an important role in teaching undergraduate and graduate courses in DAS. The courses that swine group faculty are involved in teaching include:

Designator	Name	Credits	Term	% Effort	Instructor(s)
AnSc 2013	Beg. Livestock Judging	2	Fall	100%	Hawton
AnSc 2012	Livestock & Carc. Eval.	3	Spring	100%	Hawton
AnSc 3142	Adv. Livestock Judging	2	Fall	100%	Hawton
AnSc 4401	Swine Nutrition	3	Fall	100%	Shurson
AnSc 4601	Pork Prod. Sys. Mgmt.	3	Spring	100%	Shurson
AnSc 4611	Adv. Pork Prod. Sys.	2	Spring	100%	Shurson
AnSc 4609	Anal. Lvsk. Prod. Sys	2	Spring	30%	Baidoo/Shurson
AnSc 8311	Animal Bioenergetics	3		30%	Baidoo
AnSc 8312	Protein Metabolism	3		50%	Baidoo
AnSc 8340	Concepts in Swine Nutr.	2	Fall	100%	Baidoo/Johnston/Shurson
CAPS 5165	Intro. to Animal Nutr.	4	Spring	1 lecture	Shurson
CAPS 5615	Swine Health & Disease	4	Fall	1 lecture	Shurson

Jerry Hawton provides all of the instruction for the undergraduate Livestock Evaluation and Judging Team courses. Upon his retirement, there will be a large void in the DAS undergraduate teaching program and general livestock judging activities. Jerry Shurson teaches the Swine Nutrition and Pork Production Systems courses and advises 14 -18 undergraduates interested in pre-veterinary medicine and the swine production systems areas of emphasis in the Animal Science major. As shown in the following table, Drs. Shurson, Johnston, and Baidoo co-advise undergraduate students involved in conducting research projects for their Science in Agriculture thesis. Dr. Shurson was also involved in developing and teaching a portion of the Analysis of Livestock Production Systems course with Drs. Reneau and DiCostanzo. However, in recent years, Sam Baidoo has assumed this responsibility. Although Sam has no formal teaching appointment, he has taken the initiative to teach significant portions of the graduate nutrition courses in Animal Bioenergetics, Protein Metabolism, and co-teaches the Concepts and Developments in Swine Nutrition with Drs. Shurson and Johnston. Dr. Shurson also provides guest lectures in two courses in the College of Veterinary Medicine.

Undergraduate Student Senior Theses Advising

Student	Yr Completed	Advisor(s)
Tina Becker	1999	Shurson
Amy Walsh	2000	Shurson
Jennifer Wilson	2001	Shurson
Jonathan Holt	2002	Baidoo/Shurson
Noemi Perez	2004	Shurson
Amy Poepping	2004	Shurson/Johnston
Sarah Schieck	2004	Johnston/Shurson

Graduate Students (Past 5 years)

Student	Degree	Yr Completed	Advisor(s)
Kevin Rozeboom	Ph.D.	1999	Crabo/Shurson
Albert Devries	Ph.D.	2001	Conlin/Shurson
Mindy Spiehs	M.S.	2001	Shurson
Jeff Knott	M.S.	2002	Shurson
Jennifer Wilson	M.S.	2003	Shurson
Antonio Renteria	Ph.D.	2003	Johnston/Shurson
Mark Whitney	Ph.D.	2004	Shurson
Gaofeng He	Ph.D.	2004	Baidoo
Mindy Spiehs	Ph.D.	2004	Shurson
Jeff Knott	Ph.D.	2004	Shurson
Jon Holt	M.S.	2004	Johnston
Claudia Ariza-Nieto	Ph.D.	in progress	Baidoo/Deen
Guowu Xu	Ph.D.	in progress	Shurson
Minho Song	M.S.	in progress	Baidoo
Pedro Urriola	Ph.D.	in progress	Shurson

Extension

See the Swine Extension Business Plan.