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Feeding of 60% Dried Distillers Grains in Finishing Rations Results in Acceptable Lamb Performance and Carcass Quality

C.S. Schauer[1], M.M. Stamm[1], P.B. Berg[2], D.M. Stecher[1], D. Pearson[1], and D. Drolc[1]

Dried distillers grains, replacing barley and soybean meal in up to 60% of the ration, maintained lamb performance and had no negative effect on lamb carcass traits when compared to a barley based ration.

[1]Hettinger Research Extension Center, NDSU, Hettinger, ND

[2]Department of Animal Science, NDSU, Fargo, ND

Introduction

Coproducts from the ethanol industry are increasingly available in the northern Great Plains as the ethanol industry continues to expand. Dried distillers grain (**DDG**), one such coproduct, is an excellent source of energy and protein for beef cattle and sheep (Lardy, 2003). North Dakota, Minnesota, and South Dakota annually produced about 900,000 tons of DDG, approximately 80% of which are fed to ruminants. Historically, research in beef cattle backgrounding and finishing diets report that DDG can be fed as a source of supplemental protein and/or energy, with optimum inclusion levels at approximately 20% of the diet dry matter (Lardy, 2003). However, DDG are high in potassium, phosphorus, and sulfur, and care must be used when feeding DDG at the upper limits of the recommendation. Additionally, as DDG prices stabilize and become cheaper as more product becomes available, some producers are interested in the maximum inclusion levels of DDG in finishing rations. . To prevent polioencephalomalacia in sheep, current recommendations are to keep dietary concentrations of sulfur below 0.3% DM when animals are fed concentrate diets, or 0.5% DM when fed high-forage diets (NRC, 2007). When feeding greater than 20% of the diet as DDG, dietary sulfur concentrations usually will exceed 0.3% DM. However, recent research results in cattle indicate that as much as 50% of the ration (DM basis) may contain DDG when 150 mg/hd/d supplemental thiamin is provided (Huls et al., 2008). Little research has evaluated the inclusion of dried distillers grains as a replacement for concentrate in lamb finishing rations.

Schauer et al. (2005, 2006) and Huls et al. (2006) reported that DDG can be included at levels up to 22.5% of a finishing ration with no negative affect on lamb performance or carcass traits. In fact, the supplemental energy and protein supplied by DDG, when compared to either barley or corn based diets, may in fact increase performance (Schauer et al., 2006). While it is widely accepted that DDG are an excellent source of protein and energy, the unique problems of feeding feedstuffs high in phosphorus and sulfur to sheep warrant additional research. Maintaining a calcium to phosphorus ratio of 2:1 or greater for the prevention of urinary calculi may become difficult as the level of DDG included in lamb finishing rations increases. This study was designed to evaluate how lambs respond to increasing levels of DDG in a finishing ration, specifically when sulfur concentrations become toxic, while providing supplemental thiamin to prevent polioencephalomalacia.

Procedures

A randomized complete design was used to evaluate the influence of DDG in lamb finishing diets. Two-hundred forty western white-faced Rambouillet wether and ewe lambs (69.8 ± 1.3 lbs initial BW) were stratified by weight and sex and assigned randomly to 16 pens (15 lambs/pen). Pens were then assigned to one of four diets; 0% replacement of barley with DDG (**Control**), 20% DDG in ration replacing barley (**20%**), 40% DDG in ration replacing barley (**40%**), or 60% DDG in ration replacing barley (**60%**; Table 1). Lambs were fed a finishing diet for 111 days. Diets were balanced to at

least meet crude protein, energy, and copper requirements (NRC, 2007); however, they were not kept isocaloric or isonitrogenous as level of DDG inclusion increased (Table 1). Thiamin was included at 142 mg/hd/d (DM basis) in all rations for the prevention of polioencephalomalacia. The control diet consisted of 76.5% barley and 12.5% alfalfa hay. Rations were formulated as to maintain a Ca:P ratio of 2:1 or greater and sulfur was evaluated (Table 1). Rations were mixed and ground through a grinder-mixer and provided ad-libitum via bulk feeders. Lambs were weighed on day 0, 32, 56, 83, and 111. Initial and final weights were an average of two-day weights. Following the 111 day finishing period, lambs were harvested and carcass data collected at Iowa Lamb Corp, Hawarden, IA. Feedlot performance and carcass trait data were analyzed as a randomized complete design using the GLM procedure of SAS (SAS Inst. Inc., Cary, NY). The model included treatment. Contrast statements included 1) Control vs DDG inclusion; 2) linear effect of DDG inclusion; 3) quadratic effect of DDG inclusion; and 4) cubic effect of DDG inclusion.

Results

The effects of treatments on feedlot performance and carcass traits are shown in Table 2. Final weight, ADG, Feed:Gain, Gain:Feed, mortality, hot carcass weight (**HCW**), leg score, conformation score, fat depth, body wall thickness, ribeye area, quality grade, yield grade, and % boneless closely trimmed retail cuts (**% BCTRC**) were not affected by treatment ($P \geq 0.15$). Intake increased in a linear manner ($P < 0.001$) as level of DDG inclusion increased. Additionally, flank streaking increased ($P = 0.09$) in a cubic relationship to the control as level of DDG inclusion increased.

Discussion

Dried distillers grains replacing up to 60% of the ration in a barley and alfalfa based finishing ration had no affect on lamb performance. However, intake did increase linearly as level of DDG inclusion increased. One possibility for the increase in intake was increased palatability of the ration, possibly due to increased fat concentration of the ration. Although intake increased, a significant increase in ADG was not observed. However, a numerical increase in ADG of approximately 6% was observed for all

Table 1. Dietary ingredient and nutrient composition of control and dried distillers grain diets

	Diets[a]			
Item	Control	20%	40%	60%
	%, DM basis			
Ingredient				
Barley	76.50	61.48	41.48	21.48
Dried distillers grain	---	20.00	40.00	60.00
Alfalfa	12.50	12.50	12.50	12.50
Soybean Meal	5.00	---	---	---
Ammonium Chloride	0.50	0.50	0.50	0.50
Trace mineral[b]	5.00	5.00	5.00	5.00
CTC[c]	0.50	0.50	0.50	0.50
Nutrient Concentration				
CP, %	19.80	20.10	25.10	27.20
TDN, %	79.10	81.60	84.00	84.60
$NE_{maintenance}$, Mcal/lb	0.85	0.88	0.92	0.92
NE_{gain}, Mcal/lb	0.57	0.59	0.61	0.61
Crude Fat, %	2.50	4.03	6.69	8.34
Acid Detergent Fiber, %	10.20	9.72	10.90	12.50
Sulfur, %[e]	0.22	0.32	0.47	0.55
Calcium, %	2.14	1.77	1.17	1.38
Phosphorus, %	0.48	0.55	0.66	0.67
Copper, ppm	12.00	10.00	11.00	10.00
Zinc, ppm	73.00	75.00	86.00	63.00
Thiamin, mg/hd/d	142.00	142.00	142.00	142.00

[a]Control = 0% replacement of barley with dried distillers grains; 20% = 20% dried distillers grain in ration replacing barley; 40% = 40% dried distillers grain in ration replacing barley; 60% = 60% dried distillers grain in ration replacing barley.

[b]Trace mineral: 0.12 % S, 0.31% P, 1.2% K, 1.45% Mg, 17.47% Ca, 2.82% Na, 509 ppm Fe, 375 ppm Mn, 50 ppm Cu, 715 ppm Zn, 5 ppm Se, 891 mg/lb Thiamine, 43.25 KIU/lb Vitamin A, 4.3 KIU/lb vitamin D3, 4320 IU/lb Vitamin E, 430 mg/lb Bovatec®.

[c]CTC (4G) was formulated to provide 48 g/ton chlortetracycline.

[e]Sulfur may be toxic at 0.30% of diet.

DDG treatments when compared to the control. Other researchers suggest that DDG can be an effective replacement of concentrate with no affect of livestock performance compared to control rations. Erickson et al. (1989) provided up to 28% of a finishing ration as DDG and observed no negative affects on performance. Similarly, Schauer et al. (2005) replaced up to 15% of the total ration and Huls et al. (2006) replaced up to 22.9% of the ration with DDG and found no difference in lamb performance or carcass traits. However, Schauer et al. (2006) reported an increase in performance from increasing levels of DDG at levels up to 22.5% of the ration. In both the Schauer et al. (2006) trial and the current trial, CP levels of the DDG rations are in excess of the requirements for lambs (NRC, 2007). In the control rations, CP may be limiting as corn and/or barley CP concentrations are substantially lower than DDG crude protein concentrations. Future research is needed to determine if adequate performance can be maintained while utilizing lower quality forages than alfalfa with DDG replacing a portion of the concentrate in the diet. Additionally, continued quantification of CP requirements is needed. In the current trial and in Schauer et al. (2006) the control ration was balanced for the CP requirements based on current literature, but marginal increases in ADG were observed as dietary CP increased with increasing levels of DDG.

The majority of carcass traits were not affected by increasing levels of DDG in the ration. These results are supported in research conducted by Schauer et al. (2005, 2006) and by Huls et al. (2006). In the current trial only marginal increases in flank streaking were observed, potentially the result of increased energy density in the rations with higher levels of DDG inclusion .

Table 2. The influence of dried distillers grains on feedlot lamb performance and carcass characteristics

Item	Treatment[a]					*P*-value[c]				
	Control	20%	40%	60%	SEM[b]	*P*-value	Linear	Quad-ratic	Cubic	Con. Vs. DDG
Initial Wt (lbs)	68.00	70.00	71.00	70.00	1.30	0.55	0.47	0.22	0.97	0.22
Final Wt (lbs)	132.00	137.00	137.00	137.00	2.00	0.27	0.15	0.25	0.49	0.06
ADG (lbs/day)	0.58	0.62	0.61	0.62	0.02	0.21	0.11	0.41	0.25	0.05
Intake (lbs/hd/d)	3.69	3.91	4.03	4.20	0.07	0.001	< 0.001	0.71	0.64	< 0.001
F:G	6.38	6.31	6.66	6.75	0.20	0.38	0.13	0.72	0.48	0.41
G:F	0.16	0.16	0.15	0.15	0.005	0.53	0.20	1.00	0.51	0.39
Mortality	0.75	0.25	0.25	0	0.30	0.38	0.12	0.68	0.58	0.12
HCW (lbs)	66.00	69.00	69.00	68.00	1.00	0.27	0.19	0.16	0.56	0.06
Leg score	10.30	10.50	10.50	10.50	0.30	0.89	0.56	0.66	0.84	0.45
Conformation score	10.30	10.30	10.50	10.50	0.27	0.83	0.42	1.00	0.67	0.60
Fat Depth (in)	0.29	0.32	0.30	0.32	0.02	0.57	0.36	0.69	0.33	0.24
Body Wall Thick (in)	0.96	0.98	1.01	1.02	0.03	0.47	0.13	0.87	0.82	0.22
Ribeye Area (in^2)	2.32	2.38	2.35	2.39	0.05	0.72	0.43	0.83	0.44	0.35
Flank Streaking	324.00	357.00	342.00	345.00	8.00	0.08	0.19	0.09	0.09	0.02
Quality Grade	10.30	10.80	10.80	11.00	0.20	0.15	0.04	0.57	0.45	0.04
Yield Grade	3.26	3.57	3.42	3.55	0.18	0.63	0.39	0.65	0.39	0.26
%BCTRC[d]	45.10	44.90	44.90	44.80	0.21	0.76	0.35	0.70	0.79	0.31

[a]Control = 0% replacement of barley with dried distillers grains; 20% = 20% dried distillers grain in ration replacing barley; 40% = 40% dried distillers grain in ration replacing barley; 60% = 60% dried distillers grain in ration replacing barley.

[b]Standard Error of Mean; n = 4 .

[c]*P*-value for Control vs DDG treatments and linear, quadratic, and cubic affect of dried distillers grains inclusion.

In the current trial supplemental thiamin was provided to aid in the prevention of sulfur toxicity, hopefully preventing the incidence of polioencephalomalacia. Current research suggests that sulfur toxicity in concentrate rations fed to lambs is 0.3% DM, and 0.5% DM in lamb fed high-forage diets (NRC, 2007). As concentrate levels increase in lamb diets, ruminal pH decreases and excessive production of rumen sulfide can result (Gould, 1998). While decreases in ruminal pH have not been found to decrease the microbial production of thiamin (Alves de Oliveira et al., 1996), the ruminants main source of thiamin, the decreases in pH have been found to increase the bacteria that produce thiaminase – a compound that in turn destroys the thiamin that is already present, inducing a thiamin deficiency and subsequently polioencephalomalacia (Morgan and Lawson, 1974; Boyd and Walton, 1977, Thomas et al., 1987). In rations containing greater than 0.3% sulfur, the combination of increasing dietary sulfur concentration, increased ruminal sulfide production, and increasing thiaminase production can result in an increase in polioencephalomalacia (Gould, 1998). Sulfur toxicity may additionally result in decreased intake and performance as well as health problems associated with sulfur binding to copper, resulting in copper deficiencies. One potential remedy for excessive dietary sulfur is to include supplemental thiamin in the ration (NRC, 2007). Recent beef cattle research has had mixed results with supplemental thiamin. Huls et al. (2008) successfully fed 50% of the diet as modified distillers grains plus solubles while supplementing with 150 mg/hd/d thiamin, noting no change in performance when compared to control diets. However, a 50% DDG with solubles treatment had to be discontinued by Buckner et al. (2007) when multiple steers exhibited signs of polioencephalomalacia, even though they were providing 150 mg/hd/d supplemental thiamin. In our trial, no increases in mortality or morbidity were observed, indicating that the lambs on increasing levels of DDG had no deleterious effects from increasing dietary sulfur concentrations. Additional research is needed to further quantify the supplemental thiamin needs of lambs fed high DDG rations.

Implications

The expansion of the ethanol industry in the region may result in an increase in the availability of dried distillers grains. Maximizing the use of dried distillers grains may become economically feasible for lamb feeders when prices become favorable. When appropriately priced relative to corn and/or barley, dried distillers grains and supplemental thiamin can effectively replace up to 60% of a lamb finishing ration with no negative effects on feedlot performance or carcass traits.

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Response of North Dakota Lamb and Wool Producer Association members to the National Animal Identification System Strategic Plan (NAIS)

S. Veil[1] and C.S. Schauer[2]

This study evaluates responses that North Dakota Lamb and Wool Producers Association members had to the release of the National Animal Identification System Strategic Plan (NAIS). Overall, 27% of NDLWPA respondents recommend the continuation of the scrapie tag program for animal identification purposes; 8% recommended implants; 8% recommended eliminating identification programs; and 27% did not provide recommendations. A third of the respondents did not specify a type of identification but provided recommendations for how the system should be implemented.

[1]Gaylord College of Journalism & Mass Communication, University of Oklahoma, Norman, OK

[2]Hettinger Research Extension Center, North Dakota State University, Hettinger, ND

Introduction

This study surveyed members of the North Dakota Lamb and Wool Producers Association (NDLWPA) following the release of the National Animal Identification System Strategic Plan (NAIS). Members of NDLWPA were asked their perceptions of USDA-APHIS, the National Animal Identification System, RFID technology, and the role of the North Dakota Lamb and Wool Producers Association. In addition, in order to compare the study with the previous survey of the North Dakota Stockmen's Association (NDSA), questions were asked regarding ownership of cattle and membership in NDSA.

Procedures

Conducting research as an innovation is being diffused can provide insight into the motivations for adopting or rejecting an innovation (Rogers, 2003). Rather than surveying participants after an innovation has been accepted, as is common in diffusion research, this study surveyed members of the North Dakota Lamb and Wool Producers Association (NDLWPA) following the release of the National Animal Identification System Strategic Plan (NAIS). Members of NDLWPA were asked their perceptions of USDA-APHIS, the National Animal Identification System, RFID technology, and the role of the North Dakota Lamb and Wool Producers Association. In addition, in order to compare the study with the previous survey of the North Dakota Stockmen's Association (NDSA), questions were asked regarding ownership of cattle and membership in NDSA.

Questionnaires have been used extensively in diffusion studies (Rogers, 2003). Questionnaires have also been used effectively to study risk perception and behavior related to the diffusion process (Singhal & Rogers, 2003). At the North Dakota Lamb and Wool Producers Association Annual Meeting in December 2006, open-ended questionnaires were distributed to attending members to learn their perceptions of the adoption or rejection process of RFID technology. The method was naturalistic (Lincoln & Guba, 1985) in that the researcher adopted "strategies that parallel how people act in the course of daily life" (Taylor & Bogdan, 1998, p. 8). Participants were already attending the meeting, and panels had already been scheduled during the meeting to discuss NAIS, allowing for an environment in which the participants would feel comfortable revealing related information (Taylor & Bogdan, 1998). The study was authorized by the North Dakota State University Institutional Review Board.

Participants

Participants were selected based on their attendance at the NDLWPA Annual Meeting. The participants were all adults and members of NDLWPA. Participation in the survey was voluntary, and the decision about whether to participate in the study did not affect the standing of the participants in NDLWPA. If individuals decided not to participate, they were free not to complete the questionnaire or to stop at any time. Those participating in the survey signed an informed consent form allowing the information to be studied. Of the 95 attendants, 26

participants returned questionnaires for a 27% response rate. All 26 respondents were sheep producers, however, 1 listed university and 1 listed marketing agent as additional industry affiliations. Producers were classified by length of time in the industry; 2 had been farming for under 10 years, 2 had been farming between 10 and 19 years, 8 had been farming between 20 and 29 years, 6 had been farming between 30 and 39 years, 6 had been farming for more than 40 years, and 2 did not provide how long they had been farming (Figure 1). Producers were further classified by the county in which they farm for description purposes. Producers represented 18 counties in 2 states (Figure 2). Of the North Dakotans who listed producer as at least one affiliation to the industry, 3 were from Burleigh County, 3 from Kidder, 2 from Richland, 2 from Ramsey, 2 from Adams, and 1 from Oliver, Hettinger, Sargent, Walsh, Eddy, Barnes, Dickey, Slope, Mercer, Steele, Cass, and Stutsman Counties. One producer farms in Wisconsin and another did not list the county.

Survey Environment

The organizational setting of the Annual Meeting was determined to be conducive to the process of encouraging members of NDLWPA to elaborate on their opinions, questions, and concerns regarding a major topic of discussion at the meeting (Taylor & Bogdan, 1998). Based on observation and personal communication with participants, questionnaires were completed immediately at the registration table, during the course of meetings, during discussions with other participants at lunches and banquets, and in the privacy of hotel rooms.

Survey Instrument

The questionnaire consisted of three description questions; one Likert-type scale to gauge the respondent's likeliness to adopt the technology; eight open-ended questions pertaining to the reasoning for the proposal of NAIS, advantages and disadvantages of RFID technology, perceptions of the roles of USDA-APHIS and NDLWPA, and recommendations for animal identification procedures; and three questions pertaining to whether the individuals also own cattle, are members of NDSA, and perceptions of adoption likelihood of sheep producers compared to cattle producers. Questions were composed based on feedback from members of the Biosurveillance Working Group. The questions were then pre-tested and revised based on feedback from the president of NDLWPA.

Data Collection

Questionnaires were distributed at the registration table as participants picked up their registration packets and entered the general assembly meeting. Before receiving a questionnaire, participants were asked if they had already completed a questionnaire to avoid duplication. Participants were able to complete the questionnaire at their leisure over the course of the three-day convention. In exchange for completing the questionnaire, respondents received a vented cap with the researcher's university extension center logo. In speaking with members of NDLWPA before the Annual Meeting, extension services are seen as a supportive entity to producers.

Procedures for Data Analysis

Frequency measures were used to analyze responses to questions regarding the role of NDLWPA in the adoption/rejection process of RFID technology, whether USDA-APHIS was effectively addressing the concerns of producers, the purpose of NAIS, and recommendations for tracking sheep.

Frequency measures were also used to analyze the likelihood of members to voluntarily adopt RFID technology for tracking purposes. Responses to the questions regarding the advantages and disadvantages of the innovation and the respondent's conditions for adoption were coded and classified using the subsequent procedure: (1) Following Yin's (2003) process of pattern-matching logic, responses to the three questions were analyzed repeatedly to identify barriers to the adoption process. (2) Each questionnaire was then repeatedly analyzed to determine if additional themes, as constituted by negative terms, also existed in the data. (3) Following Coffey and Atkinson's (1996) clustering of themes for organization, the themes were conceptually organized by an underlying construct (Boyatzis, 1998). Using the theoretical lens of diffusion of innovation, themes were organized into clusters relating to the five attributes that affect the adoption process. (4) Any themes identified that did not fit into the cluster classification system were documented.

Results and Discussion

When asked what role respondents thought NDLWPA should play in the adoption/rejection of RFID technology, whether they were for or against adoption, 85% (n = 22) of the respondents felt NDLWPA should be involved in the process. Suggestions ranged from having the organization be involved in the education process to implementing the system. A 20-year producer from Dickey County wrote, "The Association will be the educational tool to inform producers of opportunities and advancements in the technology." Assuming adoption will occur, a 20-year producer from Kidder County wrote, "Once RFID is accepted, Lamb and Wool could help educate people in the sheep industry on the advantages of being able to record information. Also work with research (ex. Hettinger) on best equipment." While a 21-year producer from Burleigh County felt the role of NDLWPA was to make sure the adoption did not occur until everyone agreed, "Central in policy development and 100% agreement before adoption." Other respondents looked to NDLWPA as the bridge to USDA and identified the organization an opinion leader in the industry. A producer from Sargent County explained the role of NDLWPA as "making sure that our voice is heard in adopting standards that are practical and serve a purpose to the industry." While a 6-year producer from Eddy County wrote, "They should have the final say in this process because they are the people who will implement it and make it successful."

In contrast to the support for NDLWPA, many respondents were unsure as to how well concerns were being addressed by USDA-APHIS. Some producers wrote USDA was addressing their concerns adequately (19%; n = 5), or even very well via the state veterinarian's office and university extension (12%; n=3). However, 54% (n=14) of producers specifically stated their concerns were not being addressed. A 2-year producer from Ramsey County wrote, "I don't think the government agencies will listen to the producers or others that will be using this ID system." A 34-year producer from Adams County agreed, "I don't feel that they are listening to the producers." Four producers (15%; n=4) opted not to respond.

Seeing the connection between past crises and failures in the industry, respondents referred to specific events as the motivation for proposing NAIS. Participants who mentioned BSE as reasoning for the new system represented 62% (n = 16) of the total sample, while 15% (n=4) specifically mentioned scrapies, 12% (n = 3) mentioned 9/11, and 8% (n = 2) mentioned FMD. Some producers (19%; n=5) were more general in listing disease breakout, global food safety, and consumer demand as the reason for NAIS. However, a 40-year producer from Slope County was very specific in stating the reason was "politics," and a 21-year producer from Burleigh County stated NAIS was proposed because of "Economic interests outside of the producers of the actual livestock."

In determining how likely respondents were to voluntarily adopt RFID tagging, respondents were asked to rate their likelihood to adopt on a Likert scale (Table 1). Of the 26 who responded, 12% (n = 3) had already adopted RFID, 46% (n = 12) were likely to adopt, 8% (n = 2) were undecided, 19% (n = 5) were unlikely to adopt, and 15% (n = 4) indicated they will not adopt RFID technology. A 40-year producer from Slope County wrote the only circumstances that would make him adopt RFID were "mandatory or jail time." The majority of the respondents (57%; n=15) indicated they had either already adopted or were likely to adopt RFID tagging. However, of the 12 respondents who were likely to adopt, but had not yet adopted 75% (n=9) listed conditions that need to be in place for them to adopt RFID tagging. Regardless of adoption likelihood, respondents listed 27 conditions for adoption.

Despite concerns over the reasoning behind the implementation of NAIS and some reservations in adoption, 77% (n = 20) of respondents were able to list advantages for adopting RFID technology for animal identification. Advantages included safe food, reduced animal theft, faster identification, speed of trace-back, speed of commerce, increased flock performance and profit, record retention, and determination of domestic meat from imported meat.

Table 1. Likelihood to Adopt RFID Technology

Likelihood	Number of Respondents
Already adopted	3
Likely to adopt – no conditions	3
Likely to adopt – under conditions	9
Undecided	2
Unlikely to adopt	5
Will not adopt	4

n = 26.

Meanwhile, 81% (n = 21) were able to identify disadvantages to the technology. Some respondents listed multiple disadvantages for a total of 33 comments. Using the theoretical lens of diffusion of innovation, disadvantages of the system and circumstances that needed to be in place for adoption were categorized and coded into the five attributes that affect the adoption process (Rogers, 2003).

Relative Advantage

Before anyone will replace a product or system, the advantages of the new product or system must be demonstrated. Relative advantage is defined as the degree to which an innovation is perceived as better than the idea it replaces (Rogers, 2003). The advantages must also be worth the additional costs. The scapie program already requires tagging, so the change in the system would be a different type of tag and reading equipment. At the time of the survey, USDA had not addressed who would be responsible for paying for any additional costs. Multiple respondents, like the 34-year producer from Adams County, specifically asked, "Who is going to pay for all the additional work and supplies involved with this?" Respondents who mentioned disadvantages regarding relative advantage or cost represented 42% (n = 11) of the total sample (Table 2), while 35% (n = 9) indicated relative advantage was a condition that would have to be met before adoption (Table 3). A 40-year from Slope County wrote, "Stupid to try to track – lots of work with no benefits." A 30-year producer from Stutsman County listed the disadvantage as, "Cost paid by producer – no compensation." A 6-year producer from Eddy County wrote, "I will adopt it if there is No Added Cost to me for adopting it."

Compatibility

Compatibility is defined as the degree to which an innovation is perceived as being consistent with existing values, experiences, and the needs of potential adopters (Rogers, 2003). Comments related to a need to integrate the new technology with the current system of tagging were classified as concerns regarding compatibility.

Table 2. Classification of Disadvantages

Disadvantage	Number of Respondents
Relative Advantage	11
Compatibility	3
Complexity	9
Trialability	7
Observability	3
None	5

n = 38.

Table 3. Classification of Conditions for Adoption

Condition	Number of Respondents
Relative Advantage	9
Compatibility	5
Complexity	6
Trialability	2
Observability	2
Manditory	3
None	5

n = 32.

Respondents that mentioned compatibility as a disadvantage represented 12% (n = 3) of the total sample (Table 2), while 19% (n = 5) indicated that compatibility was a condition that would have to be met before adoption (Table 3). A 36-year producer from Steele County wrote as a condition of adoption, "Convert the N.D. ID. system to the RFID system." While a 34-year producer from Adams County recommended, "That the scrapie program already in place stays the same and the sheep will not have to do anything else."

Complexity

Complexity is the degree to which an innovation is perceived as difficult to understand and use (Rogers, 2003). Concerns regarding complexity in user friendliness, compliance, and confidentiality were mentioned by 35% (n = 9) of respondents (Table 2), while 23% (n = 6) indicated that complexity was a condition that would have to be met before adoption (Table 3).

The concern over the ease of using the information was summed up in a comment from a 30-year producer from Burleigh County regarding a potential disadvantage as "Hard to use." While a producer from Cass County wrote, "Most won't do it right."

While a few comments centered on compliance, including one from 15-year Hettinger County producer listing the disadvantage, "to get 100% cooperation." Most comments regarding the complexity of the technology concentrated on the level of privacy for the information. A 21-year producer from Burleigh County felt a disadvantage to RFID was "…control of the data collected and how that info will be used." A 2-year producer from Ramsey County mirrored the question in asking, "Who has control of the information and will have access to the information?" A 25-year producer from Wisconsin specifically asked, "Will RFID results ever be used to prosecute a producer?"

Trialability

Trialability is the degree to which an innovation may be experienced on a limited basis (Rogers, 2003). Comments related to trialability or testing the technology and demonstrating that it will work were made by 27% (n = 7) of respondents (Table 2), while only 8% (n = 2) indicated that trialability was a condition that would have to be met before adoption (Table 3). A 20-year Dickey County producer listed a disadvantage as, "Accuracy of reading tags." While the main concern, as described by a Sargent County producer was "Retention of tag." A circumstance needed to be in place for adoption was listed by a 30-year producer from Burleigh County as, "Get new tags."

Observability

Observability is the degree to which the results of an innovation are visible to others (Rogers, 2003). Comments of concern, beyond if the technology would work, centered on if the respondents could see the technology working at the speed of commerce. Respondents with these concerns represented 12% (n = 3) of the total sample (Table 2), while 8% (n = 2) indicated that observability was a condition that would have to be met before adoption (Table 3). Respondents in this category did not see how RFID could work outside the test system. A 25-year producer from Wisconsin asked, "Can RFID actually work in everyday

life?" A 20-year producer from Dickey County said a disadvantage would be "Reading tags in large numbers of animals."

Other

All the disadvantages listed by respondents were encompassed by the elements of the adoption process. However, 12% (n=3) indicated a condition that would have to be met before adoption would be mandatory enrollment or a law passed (Table 3).

Recommendations

When asked what the respondents recommend for an animal identification process, 27% (n = 7) recommended the continuation of the scrapie tag currently being used; 8% (n = 2) recommended implants; 8% (n = 2) recommended eliminating identification programs; and 27% (n =7) did not provide recommendations. A third of the respondents, (31%; n=8) did not specify a type of identification but provided recommendations for how the system should be implemented. A 36-year producer from Steele Country recommended "Do it in a non-busy time for the farmer." While a 6-year producer from Eddy County recommended, "Should be kept on state control level as what we have now." A 40-year producer from Mercer County simply suggested, "Cheap, permanent, easy."

Recognizing the impact of NAIS on cattle producers as well as sheep producers, respondents were asked if they also owned cattle. Of the respondents who also own cattle (46%; n=12), only 25% (n=3) responded they were likely to adopt RFID tagging. In comparison, of the 54% (n=14) of respondents who only own sheep, 86% (n=12) said they are either likely to adopt or have already adopted RFID tagging. A producer from Sargent County stated the reason for the difference as, "Tradition – stockmen's still believes branding is adequate form of animal tracking (flawed) sheep producers don't have that same stigma." While a 20-year producer from Kidder County wrote, "We already do scrapies so we are started."

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Table 4. Recommendations for Animal Identification

Recommendation	Number of Respondents
Tagging	7
Implants	2
No Animal ID	2
No Recommendation	7
Implementation Recommendation	8

n = 26.

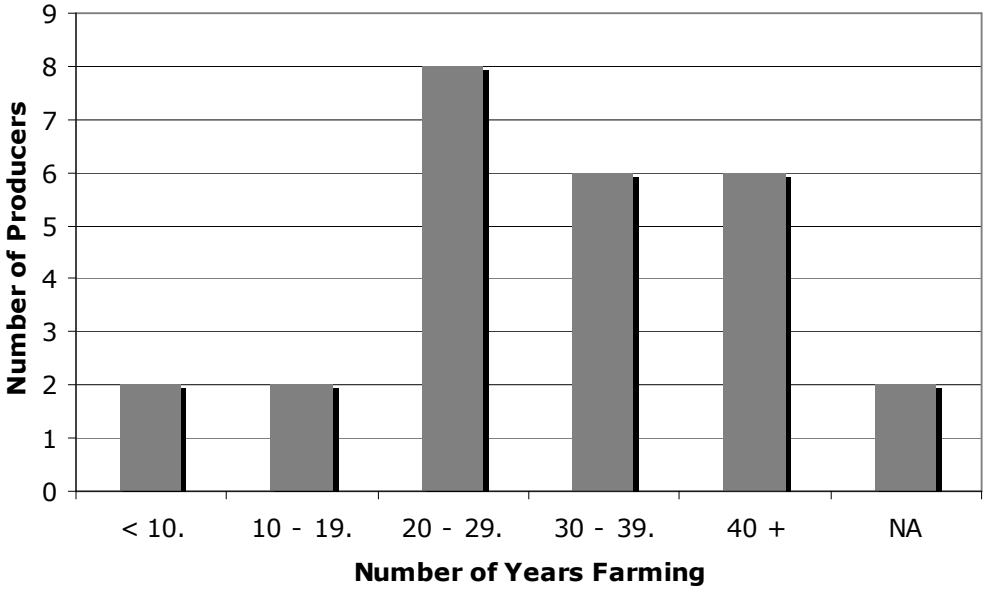

Figure 1. Number of Years Farming Graph shows how long participating producers have been farming.

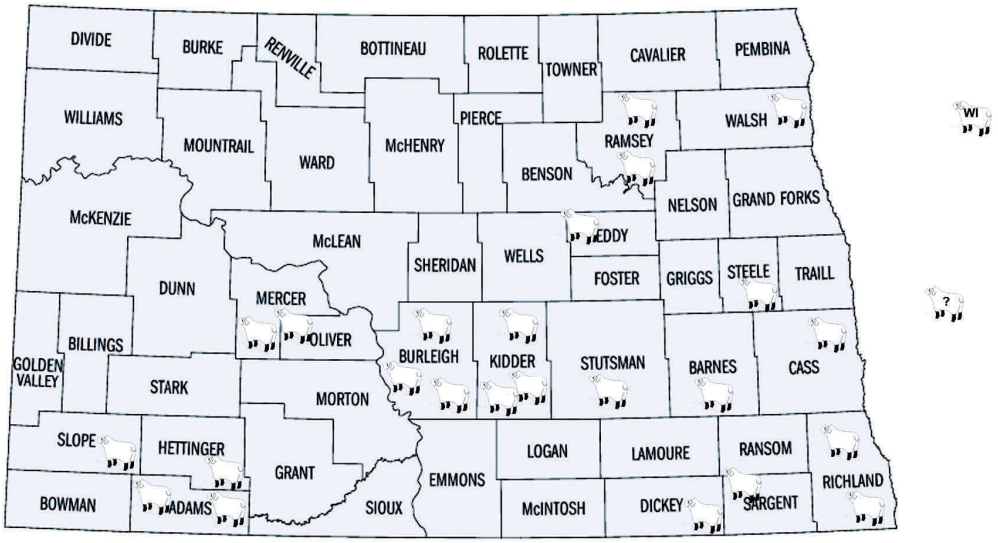

Figure 2. Producer Participant Map shows the counties in which respondents farm.

Diagnosis of Ovine Abortion – Getting the Most Out of Your Diagnostic Laboratory

N.W. Dyer[1]

Introduction

When samples for ovine abortion workup are submitted to the veterinary diagnostic laboratory at North Dakota State University, there are four infectious agents that are primary target of our investigation. They are *Toxoplasma gondii*, *Campylobacter fetus* or *jejuni*, *Chlamydophila psittaci*, and *Salmonella arizonae* (as well as other *Salmonella* serotypes). When a sheep fetus or tissues from a sheep fetus are processed, several tests are run which will help us determine if any of these pathogens is responsible for the abortion. Ideally, the entire fetus and placenta should be submitted to the laboratory, and the pathologist of record is able to select tissues and samples for analysis. However, if the post mortem examination is done on the farm or ranch, the tissues to submit for optimal results include the brain, heart, lung, a piece of the diaphragm (the thin wall of muscle between the thoracic and abdominal cavities), liver, kidney, spleen, stomach contents (collect in a syringe), and heart sack or chest fluid (collect in a syringe). When possible, include the placenta, and a serum sample from the dam. ***Remember, most of these organisms can cause significant disease in humans, therefore, always handle sheep fetuses, tissues, and placentas with rubber or latex gloves.***

Toxoplasma gondii

T. gondii is a parasite, a one-celled organism belonging to a group known as protozoans. In order for the organism to successfully survive in nature, it must spend part of its life cycle inside a member of the cat family, domestic or wild. The cat excretes the infective form of the parasite, the oocyst, in its feces which is then ingested in contaminated feed by a susceptible ewe. This is why it's advisable to restrict, or, if possible, eliminate the access of cats to sheep feed locations. The classic feature (lesion) associated with *T. gondii* abortion is inflammation and tissue damage (necrosis) of the cotyledons on the placenta. In some cases, they may become calcified. This change can be observed with the naked eye (grossly) if the placenta is washed, and one of the suspect cotyledons suspended in a salt solution. The surface of the cotyledon unwinds and exposes the necrosis/calcification which looks white and feels gritty. However, this will give a tentative diagnosis only, and it is necessary to submit fresh and formalin-fixed placenta to the lab for confirmation under the microscope. *T. gondii* infection will also cause damage in the fetal brain, so it is important to submit brain for suspect *Toxoplasma* cases. Your veterinarian can help with the collection of needed tissues. Special staining procedures are available (immunohistochemistry) which allow the actual organism to be highlighted in infected tissue. A pathologist will view the stained sample under the microscope and identify the parasite. DNA from the parasite can be detected by a method known as the polymerase chain reaction (PCR). This procedure is not typically offered by all laboratories, but it is a tool than can help with diagnosis. Finally, it is possible to detect antibody to *T. gondii* in samples of fetal fluid, either from the chest or heart sack, and fetal blood. The presence of antibody to the organism in the fetus indicates exposure to the

[1]Veterinary Diagnostic Laboratory, NDSU, Fargo, ND

parasite, and identifies it as the cause of abortion. So, in a typical *Toxoplasma* abortion, observation of necrosis in the placenta and brain, followed by special staining of the tissue ought to identify *Toxoplasma gondii* as the cause. Polymerase chain reaction and serology are available as needed for confirmation. One final note: please remember that *T. gondii* is a human pathogen, and can cause severe disease in immunocompromised individuals. This group of people would include the elderly, those with chronic disease, cancer chemotherapy patients, organ transplant patients, anyone on therapy to suppress the immune system, AIDS patients, and the very young. In addition, it is capable of causing abortion in humans, therefore pregnant women should exercise care around lambing facilities, and limit or eliminate exposure to cat fecal matter (litter boxes, gardens, playgrounds, etc.).

Campylobacter fetus/jejuni

Campylobacter is a bacteria which causes abortion in sheep. The classic gross lesions associated with *Campylobacter* abortion are large, circular, white spots on and in the liver. Unfortunately, these areas of liver damage do not occur in all cases, and cannot be relied on for diagnosis. In addition, there may be microscopic evidence of fetal pneumonia, and inflammation in the placenta. The bacteria are best isolated from abomasal contents, so it is important to submit abomasal fluid along with tissue if the entire fetus cannot be submitted to the laboratory. It is possible to look at a wet mount of abomasal contents and actually see the comma-shaped *Campylobacter* bacteria. Premises become infected when the bacteria are shed in the fecal matter of a carrier ewe. This contaminates feed and water which are ingested by susceptible ewes. The bacteria gains access to the bloodstream and travels to the placenta where it causes tissue damage and abortion. This organism is not considered a cause of disease in humans.

Chlamydophila abortus

C. abortus is the cause of enzootic abortion in sheep. The older name for this organism was *Chlamydia psittaci*, but has been changes to the current designation. Typical changes associated with *Chlamydophila* abortion include inflammation of the placenta, brain, liver, spleen, lymph nodes and blood vessels. In some cases, the bacteria can be identified by special staining methods. Serological tests are available as well. Ewes become exposed by ingesting material contaminated with the bacteria, and it is usually the younger ewes which are affected. This is because older animals will develop immunity over time, and have some natural protection from the organism. When examining aborted fetuses, hemorrhages may be seen in muscle and subcutaneous tissue. There is often fluid accumulation in the thoracic and abdominal cavities. The placenta may be inflamed to the point of appearing leathery. A normal placenta is very thin and clear; in fact, it should be possible to see through normal placental tissue. The bacteria can be isolated using special culture techniques, but the disease is usually identified through observation of microscopic changes, serology or PCR. *C. abortus* has been reported to cause abortion in humans, therefore anyone working with aborted lambs or aborting ewes should observe good hygiene to limit exposure to potential pathogens. This would include the use of rubber or latex gloves, thorough handwashing, and reduction or elimination of exposure of pregnant women to sheep abortions.

Salmonella arizonae

S. arizonae is a bacterium which causes sporadic abortion in sheep. In fact, several types of *Salmonella* can cause abortion. Quite often, the ewe will show some signs of illness (fever, diarrhea) as well. Ewes usually recover, but can die of uterine infections. The best method of diagnosis is through culture of fetal tissues collected at necropsy. Placenta, fetal tissues and vaginal discharge would all be appropriate samples for culture. The *Salmonella* organism is ingested by a susceptible ewe and then by means of the bloodstream infects the pregnant uterus. Microscopic changes in fetal tissues are related to widespread damage caused by the bacteria in blood. The diagnostic laboratory is able to use enrichment techniques to select for the *Salmonella* bacteria in suspect samples. Stains are then forwarded to the National Veterinary Services Laboratory in Ames, Iowa for serotype identification. Additional diagnostic techniques are available, but culture and histopathology remain the best method of diagnosis for *Salmonella* abortion. As was the case with *Toxoplasma* and *Chlamydophila*, *Salmonella* can cause disease in humans, and so observing proper hygiene is important.

Implications

The aforementioned agents are considered the primary causes of infectious abortion in sheep. While they are not the exclusive causes, these four are part of any routine ovine abortion workup in the upper Midwest. While the clinical pattern of abortion may help focus the investigation, there is enough variation in how abortion outbreaks appear to warrant a search for all of these pathogens. Selection of a full set of tissues as mentioned in the introduction is critical, as well as submission of placenta and serum from the dam where possible. The laboratory can take this material and generate results which will identify or rule out the problem. If none of these agents are identified, the producer can use the "negative" diagnosis to look at other possible problem areas such as nutrition, environment, or genetics. Due to the potential for human disease, it is important that individuals at risk reduce or eliminate exposure to aborting sheep and aborted fetuses.

Creation of Parthenogenetic Sheep Embryos: Preliminary Study

Anna T. Grazul-Bilska, Pawel P. Borowicz, Dale A. Redmer, Jerzy J. Bilski and Lawrence P. Reynolds

The monoparental embryo (in other words, with only the maternal genome, termed a parthenogenote, or with only the paternal genome, termed an androgenote) is a powerful model to study the imprinting status of developmentally regulated genes – that is, genes that are expressed (turned on) only when inherited from one parent. Therefore, to use monoparental embryos for future study of placental development in normal and compromised pregnancies, the objective of this study was to test, validate and optimize the methodologies necessary to create parthenogenetic sheep embryos. Cumulus oocyte complexes (COC) were collected from nonpregnant and pregnant ewes and matured overnight in maturation medium. The oocytes were activated using ionomycin (a calcium ionophore) and 6-dimethylaminopurine (DMAP; a protein kinase inhibitor); further, a portion of the oocytes was activated in medium containing serum and another portion was activated in serum-free medium. After activation of oocytes in medium containing serum, 70 to 83% of the oocytes had cleaved (indicating activation of embryonic development) and 14 to 33% of the cleaved oocytes developed to the blastocyst stage. Activation of oocytes in serum-free medium resulted in minimal cleavage rates. Thus, parthenogenetic embryos should be created using activation medium containing serum. This study demonstrated that creation of parthenogenotes is feasible and that parthenogenetic embryos can be used in the future to study parentally imprinted genes.

Department of Animal Sciences; Cell Biology Center; Center of Nutrition and Pregnancy, North Dakota State University, Fargo, ND.

Introduction

The term parthenogenesis is defined as the production of an embryo from a female gamete without any contribution from a male gamete, with or without the eventual development into an adult. In fact, spontaneous parthenogenesis occurs in many species (Rougier and Werb, 2001). The use of monoparental embryos is a powerful model to study the imprinting status of developmentally regulated genes (Dean et al., 2001), but its use is limited due to nuclear non-equivalency. That is, mammalian chromosomes of both maternal and paternal origin are required for development to term. The monoparental embryo phenotype exhibits poor development of one derivate (embryonic or extraembryonic tissue), and overdevelopment of its counterpart, and therefore constitutes a unique model for studying defects in placentation and the epigenetic status of genes regulating placental function (Dean et al., 2001; Reik et al., 2003). Monoparental embryos can be experimentally produced by artificial activation of the egg (parthenogenotes, containing only maternal genes) or by micromanipulation of the sperm or male pronucleus (androgenotes, containing only paternal genes), and both have been successfully established in several species including sheep (Loi et al., 1998; Alexander et al., 2006; Ptak et al., 2006), cows (Lagutina et al., 2004; Matsushita et al., 2004), pigs (Prather, 2001), mice, primates, and various others (Yamano et al., 2000; Rougier and Werb, 2001; Edwards, 2007).

Several protocols have been used to successfully create parthenogenetic sheep embryos (Loi et al., 1998; Bogliolo et al., 2000; Alexander at al., 2006; Ptak et al., 2006). However, sheep parthenogenetic embryos have not been created in any American laboratory for further study. We hypothesized that in our experimental conditions we would be able to create ovine parthnogenotes using two types of activation medium. Therefore, the aim of this study was to test, validate, and optimize a protocol to obtain parthenogenetic ovine embryos for future studies of placental development in normal and compromised pregnancies.

Material and Methods

Oocyte collection and in vitro maturation

Ovaries were collected at slaughter from mature nonpregnant or pregnant Western range-type ewes (n = 20) of mixed breeds (predominantly Targhee x Rambouillet) or Romanov breed (n=3). Ovaries were transported to the laboratory in an incubator at 39°C. Cumulus oocyte complexes (COC) were isolated by opening each visible follicle with a scalpel blade and flushing it with oocyte collection medium [medium TCM199 with 2% fetal bovine serum (FBS), heparin and penicillin/streptomycin (P/S)]. Under a stereomicroscope, COC were recovered from the collection dish and transferred to a petri dish containing fresh collection medium without heparin. Cumulus oocyte complexes were then washed three times in maturation medium [TCM-199 containing 10% fetal bovine serum, ovine FSH (5 μg/mL; oFSH-RP-1; NIAMDD-NIH, Bethesda, MD, USA), ovine LH (5 μg/mL; oLH-26; NIADDK-NIH),

estradiol -17β (1 µg/mL; Sigma St. Louis, MO, USA), glutamine (2 mM; Sigma), sodium pyruvate (0.25 mM; Sigma), epidermal growth factor (10 ng/mL; Sigma), and P/S (Gibco, Grand Island, NY, USA); Grazul-Bilska et al., 2003, 2006; Luther et al., 2005; Borowczyk et al., 2006]. Three separate cultures performed at three different time points (October to December) were carried out. Oocytes were matured in vitro in maturation medium for 24 h at 39°C in 5% CO_2 and 95% air followed by cumulus cell removal using 1% (wt/vol) hyaluronidase (Type I, Sigma) in PBS. Oocytes were then transferred to equilibrated activation medium (TCM199 with P/S and with or without 2% FBS).

In vitro activation

A portion of the oocytes was activated in activation medium with 2% FBS and another portion was activated in activation medium without serum; both in the presence of ionomycin (5 µM; Sigma) for 5 min at 37 C. For washing, all oocytes were then transferred to culture medium consisting of synthetic oviductal fluid (SOF; Stenbak et al., 2001) containing bovine serum albumin, glutamine, MEM, and BME amino acids and P/S; the washing was followed by a 3 h incubation in culture medium containing 2 mM 6-dimethylaminopurine (DMAP, a protein kinase inhibitor; Sigma). Oocyte treatment with ionomycin and DMAP was performed in 95% air and 5% CO_2. After treatment, the oocytes were washed in culture medium twice.

Embryo culture

All activated oocytes were incubated at 37 C in 5% CO_2; 5% O_2; 90% N_2. After 24 h of incubation, cleaved oocytes (indicating embryonic development) were transferred to culture medium with glucose (1.5 mM), and incubated for 8 days at 37 C in 5% CO_2; 5% O_2; 90% N_2. Every second day the stage of embryonic development was evaluated and embryos were transferred to fresh culture medium with glucose.

Results

In three separate experiments, activation of oocytes in medium containing serum resulted in the creation of parthenogenetic embryos (Fig. 1). The rate of cleavage was 70% in culture 1, 73% in culture 2, and 86% in culture 3. The rate of cleavage of oocytes activated in medium without serum was less than 5%. The rate of blastocyst formation after activation in medium containing serum was 14% in culture 1, 22% in culture 2, and 33% in culture 3. None of oocytes activated in medium without serum developed to the blastocyst stage. Fig. 1 shows parthenogenetic embryos from the 8-cell to the blastocyst stage, from day 4 to 8 after activation.

Discussion

The present study demonstrated that creation of parthenogenetic embryos from oocytes obtained from North Dakota Western type and Romanov sheep is possible. Furthermore, our study has shown that activation medium should be supplemented with serum obtain high rates of embryonic development. Other researchers also obtained similar results, with high rates of oocyte activation manifested by cleavage and parthenogenetic embryonic development to the blastocyst stage in sheep (Loi et al., 1998; Bogliolo et al., 2000; Alexander at al., 2006; Ptak et al., 2006). By using a protocol similar to ours, the rates of cleavage ranged from 65 to 83% and blastocyst formation rates ranged from 27 to 58% (Loi et al., 1998; Ptak et al., 2006). When ionomycin treatment or electric stimulation was used followed by incubation with DMAP or cycloheximide, the rates of cleavage and blastocyst formation were also quite high (81 to 83 and 15 to 21%, respectively; Loi et al., 1998; Ptak et al., 2006). However, replacement of ionomycin with ethanol treatment resulted in decreased blastocyst formation (from 58% to 19%, respectively) but not cleavage rates (83 and 81%, respectively; Loi et al., 1998). Unfortunately, it is unclear if these researchers supplemented activation medium with serum (Loi et al., 1998; Ptak et al., 2006). Thus, addition of serum to the activation medium seems to be critical to obtain high yields of parthenogenetic sheep embryos in our laboratory.

In cows, activation of oocytes using ionomycin and DMAP or cycloheximide plus cytochalasin B resulted in 93.6% or 77.5% cleavage, and 14% or 6% blastocyst formation rates, respectively (Lagutina et al., 2004). In addition, replacement of ionomycin with calcium ionophore A23187 followed by DMAP treatment resulted in 83% cleavage and 29% development of blastocyst stage, and these rates of development were similar to obtained after in vitro fertilization (Gougoulidis

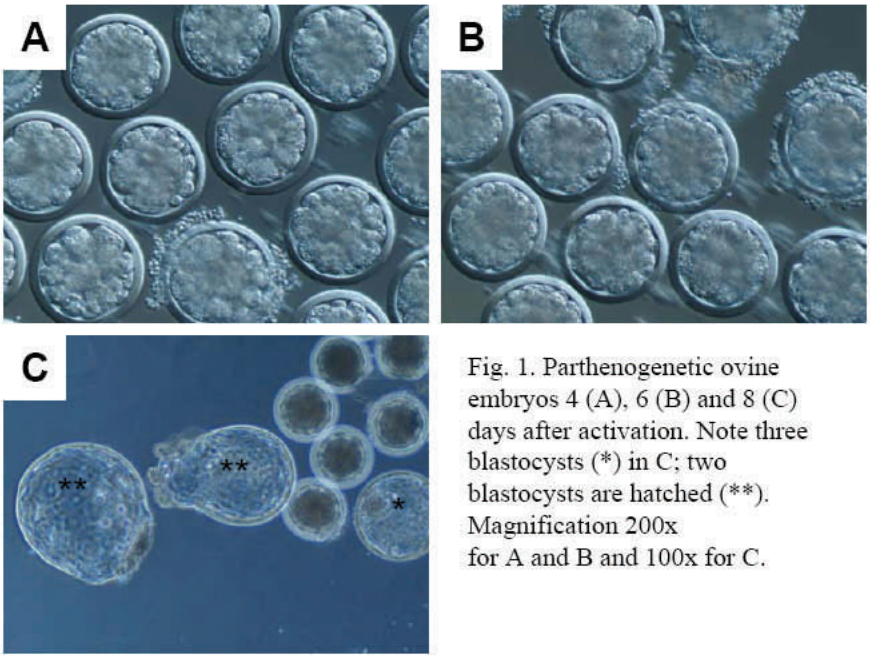

Fig. 1. Parthenogenetic ovine embryos 4 (A), 6 (B) and 8 (C) days after activation. Note three blastocysts (*) in C; two blastocysts are hatched (**). Magnification 200x for A and B and 100x for C.

et al., 19999). In another study, the rate of blastocyst formation was 25% after oocyte stimulation with direct current pulses and treatment with cycloheximide plus cytochalasin B (Matsushita et al., 2004). Thus, the activation protocol may have a profound effect on success of the oocyte activation to obtain parthenogenetic embryos.

In addition to the above mentioned oocyte activation factors, several other factors can activate oocytes to induce parthenogenetic development, including chilling or warming, exposure to colchicine, exposure to electric pulses in the presence of GlutaMAX-I, pricking, certain anesthetics, and factors disturbing the balance between free calcium and the state of the cycloskeletal system (Yamano et al., 2000; Pivko et al., 2004; Edwards, 2007).

The parthenogenetic embryo is a powerful tool to study gene imprinting (Lyle, 1997; Rougier and Werb, 2001; Okamura and Ito, 2006; Edwards, 2007). Genomic imprinting is a functional specialization of the paternal and maternal genomes, and leads to the expression or repression of genes solely on the basis of the parent from which they were inherited (Rougier and Werb, 2001). In fact, with imprinted genes a maternally inherited gene is not equivalent to a paternally inherited one; whereas the paternal genome seems essential for the normal development of extraembryonic tissues, including the placenta, the maternal genome may be essential for some stages of embryogenesis (Rougier and Werb, 2001). Furthermore, parthenogenentic embryos can be used to create stem cells for further research and/or for therapeutic cloning (Rougier and Werb, 2001; Fangerau, 2005).

In summary, parthenogenetic embryos were created in our laboratory using activation medium containing serum and ionomycin followed by treatment with DMAP. In the future, such parthenogenetic embryos will be used to study the role of imprinted genes during placental development.

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Lamb Livestock Risk Protection Insurance

Tim Petry

The USDA Risk Management Agency (RMA) began offering a pilot program called Livestock Risk Protection – Lamb (LRP-Lamb) on September 17, 2007. It is a price risk management tool for slaughter weight lambs which as designed to help lamb producers insure against dramatic price declines.

LRP-Lamb is available to producers in 27 states including North Dakota, South Dakota, Minnesota and Montana.

Policies are sold only by crop insurance agents, but not all agents are authorized to sell LRP. A list of approved agents is available on the RMA web site at: www3.rma.usda.gov/apps/agents/index.cfm. To ensure that all lamb producers have access to an agent, the American Sheep Industry Association (ASI) has created an independent insurance agency, Food and Fiber Risk Managers, LLC. More information can be found on their site at: www.fafrm.com.

Lamb producers who are considering purchasing LRP must first submit a one-time application for approval. Since the approval process may take several days, producers are encouraged to apply at a crop insurance agency a week or more before they actually plan to purchase a policy. Once a policy is approved, producers are eligible to purchase a Specific Coverage Endorsement (SCE). Each SCE will cover from 1 to 7,000 head of lambs. The annual limit of lambs that can be insured per producer is 28,000 head for the crop year which runs from July 1 to June 30.

LRP-Lamb is available only once per week on Monday from 10:00 a.m. to 7:00 p.m. Central Time. Every Monday morning RMA publishes coverage prices, premium costs, and maturity dates on the RMA website at: www3.rma.usda.gov/apps/livestock_reports/main.aspx.

Four coverage prices, at 95, 90, 85 and 80 percent of an expected ending value, are available for each endorsement length. Endorsement lengths are available for 13, 26, and 39 week time periods, which should correspond as close as possible to the actual marketing date for lambs.

Expected ending values are computer generated, projected prices that are expected to occur at the end of the coverage period. Prices are based on a national average price called "formula prices established for previously slaughtered lambs (live basis)," that is published in the USDA Agricultural Marketing Service (AMS) report titled "National Weekly Slaughter Sheep Review." That report is issued each Friday afternoon at 3:00 p.m. Central Time and is available on the AMS web site at www.ams.usda.gov/mnreports/lm_lm352.txt. The actual ending value at policy maturity is the price quoted in that report.

Actual ending value prices from the AMS report for 2005, 2006, and 2007 are shown in Figure 1. Prices ranged from a high of $115.50 per hundredweight (cwt.) in June 2005 to a low of $66.06 in May 2006. Prices declined almost $24/cwt. in the first five months of 2006, which is a good

NDSU Extension Livestock Economist, Fargo, ND

example of an adverse price decline that LRP-Lamb was designed to insure against.

On the maturity date, if the actual ending value is below the coverage price, an indemnity will be paid to the producer. Producers do not have to sell the lambs at maturity, but they must not sell lambs until 30 days prior to the maturity date. The actual weight and sales price that is received for lambs at a market has no bearing on the LRP contract, so producers have an incentive to get the highest price possible for lambs.

Producers must estimate the market weight for the lambs along with the coverage price and endorsement length when the SCE is finalized at the crop insurance office. Estimated market weights must be between 50 and 150 pounds. Furthermore lambs must be owned and located at a producer's farm, ranch, or feedlot when the SCE is finalized.

Premiums must be paid before the SCE is submitted for approval, and are shown on the RMA website each Monday. Higher coverage prices have higher premiums and longer endorsement periods also require higher premiums. However, all premiums are subsidized 13 percent by RMA. The subsidized premium for a 130 pound lamb with a 13 week endorsement period and a $100/cwt coverage price would be about $1.74 per hundredweight.

Educational information, including current coverage prices that are updated weekly, is available on my website www.ag.ndsu.edu/aginfo/lsmkt/livestock.htm. Click on the presentation titled "Livestock Risk Protection – A New Price Management Tool for Lamb Producers."

ASI has an excellent online educational course for LRP available at: www.sheep.industrynews.com/LRP_Lamb.

The basic LRP policy, handbook, frequently asked questions, fact sheets, underwriting rules, forms, and premium calculation worksheets are available on the RMA website at: www2.rma.usda.gov/livestock.

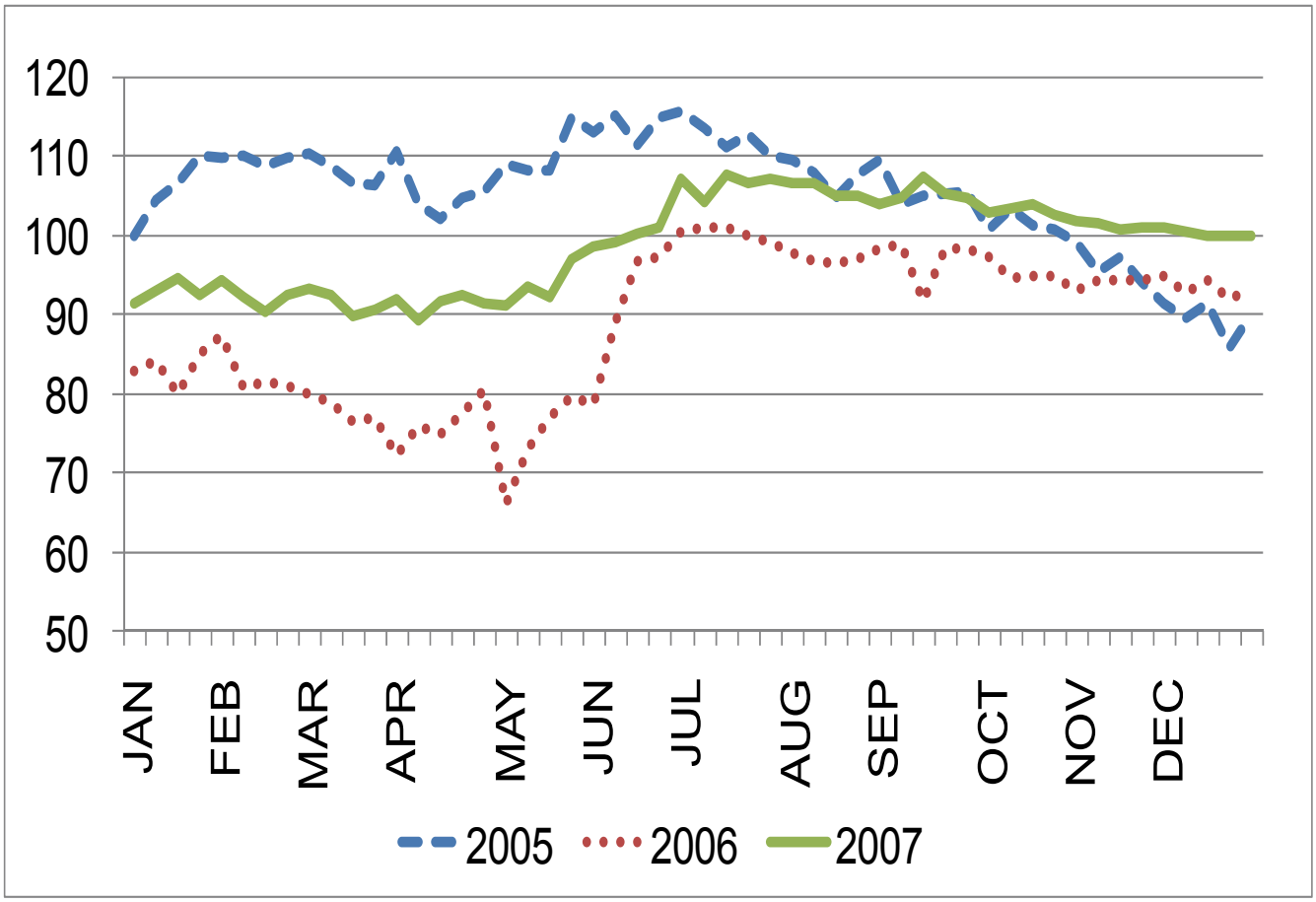

Figure 1. LRP-Actual Ending Lamb Prices

Effects of maternal undernutrition and selenium intake on fetal weight, placental weight, and placental endothelial nitric oxide synthase mRNA expression in ewes

L. A. Lekatz, D. A. Redmer, L. P. Reynolds, J. S. Caton, and K. A. Vonnahme

Maternal nutrition during pregnancy is important for several reasons including fetal growth. Producers should be particularly interested in maternal nutrition since optimal fetal growth will ultimately lead to production efficiency after birth. The placenta transfers nutrients through the blood stream from the dam to the fetus; therefore, proper placental function is necessary to insure the fetus is receiving adequate nutrition for growth and development. Endothelial nitric oxide synthase (eNOS) is a factor necessary for proper blood flow. This report focuses on two studies in our laboratory that investigate how maternal intake during pregnancy impacts fetal weight and placental weight. In addition, eNOS gene expression in the placenta was measured to better understand how blood flow in the placenta may be altered by dietary treatments. In our model, nutrient restriction during late-gestation reduces fetal weight; however, placental weight was not altered, whereas eNOS was reduced by restriction and high selenium treatments. Further research is needed to determine proper timing of realimentation necessary for adequate placental function.

Center for Nutrition and Pregnancy, Animal Science Department, NDSU, Fargo

Introduction

Maternal Nutrition and Developmental Programming

The relationship between maternal nutrition and fetal growth is important for determining pregnancy success, neonatal morbidity and mortality, and ultimately life long health and productivity. Since profitability in the livestock industry is dependent upon efficiency of production characteristics, such as growth and development after birth, the precursor of efficiency, i.e. fetal growth, must be optimal.

"Developmental programming" is the concept that a stimulus or insult to the mother during pregnancy can have long-term effects on the developing fetus (Barker et al., 1993). Maternal nutrition has been shown to alter birth weight and may influence the health and productivity of the offspring later in life (Barker et al., 1993). Our laboratory has been working to better understand how maternal nutrition can affect the offspring of our livestock species.

Importance and development of the placenta in sheep

The placenta is the organ that transfers nutrients from the dam to the fetus during pregnancy. For this reason, the placenta is not only important for the maintenance of the pregnancy, but also for the health of the fetus. Because of its important role in nutrient transport, it is not surprising that research has demonstrated fetal growth restriction is highly correlated with reduced placental growth and development (Reynolds and Redmer, 1995). If the placenta is not properly transporting nutrients, the fetus may suffer a nutrient deficiency due to placental inefficiency.

In the sheep, the placenta attaches to caruncles, which are discrete sites on the uterine wall. These caruncles make up the maternal portion of the placenta. The fetal portion of the placenta is known as the cotyledon, and this tissue interdigitates with the maternal tissues of the placenta. Together, the maternal and fetal tissues form a button-like structure known as a placentome. The placentome is highly vascular and is the site of nutrient exchange between the dam and the fetus. There are several factors that regulate blood flow, including nitric oxide, which is released by endothelial nitric oxide synthase (eNOS) activity. It stands to reason, that the greater the level of eNOS in the placenta, the greater the blood flow and, therefore, nutrient exchange between the dam and fetus. Research has shown that about 90% of placental growth in the sheep occurs by day 90 of gestation; however, at this time, only 10% of fetal growth has occurred (Redmer, et al., 2005). It is likely that maternal nutrition may impact the development of the placenta before day 90, only later to affect the function of the placenta when the fetus is exponentially growing. Therefore, improper placental development could lead to poor fetal growth.

Selenium

Selenium is an essential trace mineral for normal growth and development of livestock. Over the past decade, the view on selenium has changed drastically. It was once thought that too

much selenium was toxic, and strict guidelines on the recommended levels of selenium were put in place. Now, selenium is recognized as an important trace mineral that may be anticarcinogenic and provide other health benefits when taken at supranutritional levels (Clark et al., 1996). The USDA reports that much of the Midwest, including pockets of North and South Dakota, has high levels of selenium in the soil, making it likely that forages will have a high selenium content. Little data exist demonstrating the effects of supranutritional levels of maternal selenium intake during pregnancy, and our laboratory has been working to better understand what role selenium may play in developmental programming.

Our laboratory has recently focused on how both maternal undernutrition and selenium intake during pregnancy affect the placenta and the offspring. This report will cover some of our findings from these studies.

Materials and Methods

Experiment One

All studies were approved by the North Dakota State University Animal Care and Use Committee. In experiment one, 36 Targhee-cross ewe lambs were used. Twenty-one days prior to breeding all ewes were assigned to either a high-selenium group (HSe) that received a pelleted selenium supplement (~43 ppm Se) or to an adequate selenium treatment group (ASe) that received a pelleted supplement containing no added selenium (~0.32 ppm Se). Selenium supplementation continued until the end of the study at day 135 of gestation. All ewe lambs received a similar diet consisting of chopped alfalfa hay top dressed with corn. On day 64 of gestation, ewe lambs were either assigned to a control-diet group that received 100% of NRC requirements (CON) for a gestating ewe lamb, or to a restricted-diet group that received 60% of this amount (RES). Dietary treatments also continued until the end of the study at day 135 (Figure 1). On day 135 of gestation, fetuses and placentomes were collected and weighed. Further, a portion of caruncular and cotyledonary tissue was frozen for eNOS mRNA expression.

Experiment Two

For the second study, 64 Targhee-cross ewe lambs were assigned to a treatment. Treatments were similar to experiment one with the following exceptions. This study focused on the affects of maternal undernutrition and selenium intake, and it also took into account what role the stage of pregnancy played on the affects of these treatments. At breeding (day 0), ewe lambs were assigned to an adequate selenium group (ASe) or a high selenium group (HSe). Selenium treatments were given throughout the study until slaughter at day 130 of gestation. All ewes received 100% NRC requirements from breeding until day 50 of gestation at which time the plane of nutrition treatments were assigned. During mid-gestation, from days 50 to 90, ewes received 100% NRC requirements (CON) or 60% of this amount (RES). During late-gestation, from days 90 to 130, ewes received 100% NRC requirements (100) or 60% of this amount (60; Figure 2). On day 130 of gestation, fetuses and placentomes were collected and weighed, and caruncular and cotyledonary tissue was frozen for eNOS mRNA expression.

Results

In experiment one, fetal weight on day 135 of gestation from RES ewe lambs were reduced compared to the CON ewe lambs ($P = 0.02$; 11.58 vs. 13.16 ± 0.42 lbs). However, placentome weights did not differ between groups. Placental efficiency, which is a measure of total fetal weight divided by total placentome weight, was reduced in the RES group compared to the CON group ($P = 0.06$; 10.42 vs. 11.53 ± 0.40). Selenium levels did not have any effect on either fetal or placentome weight. Placental expression of eNOS was not different in any of the groups.

In experiment two, fetal weight on day 130 of gestation from the RES ewe lambs that were restricted during late-gestation were reduced compared to the control ewe lambs ($P = 0.01$; 9.02 vs. 9.96 ± 0.02 lbs). As in experiment one, placentome weights did not differ between groups. In this study, placental efficiency was not different. Selenium did not have an effect on fetal or placentome weights. The levels of eNOS expression in the maternal placental tissues (caruncle) at day 130 was higher ($P = 0.04$) in the group fed both ASe and the CON diet during late-gestation compared to all other groups (ASe-RES, HSe-CON, and HSe-RES) (Figure 3). During mid-gestation (Figure 4) and late-gestation (Figure 5), HSe-CON ewe lambs had reduced ($P = 0.04$) cotyledonary eNOS expression compared to the ASe ewes (Figure 4). RES ewes fed ASe or did not differ in cotyledonary eNOS expression.

Discussion

In both experiments, fetal weight was reduced in the restricted group, demonstrating that maternal nutrient restriction from day 64, or day 90, is important in determining fetal weight. It is interesting to note that in experiment two, when ewe lambs were restricted during mid-gestation, and then realimented, fetal weight was not altered, indicating that nutrient restriction from day 90 to 130 alone is enough time to reduce fetal weight by day 130.

Despite the fact that fetal weights were reduced, it appears that placental growth was spared, regardless of nutritional levels. Furthermore, even though placental weight was not impacted, the reduction in fetal weight could have been caused by one of two events: the amount of nutrients alone was not enough to attain proper fetal growth regardless of placental function; or if an excess of nutrients were available, placental function was altered such that adequate nutrient delivery was reduced. When nutrient restriction occurs earlier in pregnancy (~ day 30 to 80), placental weight is reduced (Heasman et al., 1999) and reductions in vascularity of the placenta are observed in restricted ewes (Vonnahme et al., 2003). Furthermore, maternal nutrient restriction can result in reduced fetal weights during early

to mid pregnancy. These data, taken together with our data, suggest that placental weight may be dictated by nutritional levels earlier in pregnancy, and nutrient levels after day 50 are not restrictive of placental growth near term.

Even though maternal nutritional levels from mid to late pregnancy did not impact placental weight, we may have influenced placental function. We examined expression of eNOS in both the maternal and fetal tissues of the placenta. It appears that nutritional levels imposed after day 64 do not impact the expression of eNOS. However, in experiment two where nutrient restriction began 14 days earlier, placental eNOS expression was reduced in all late-gestation groups except for the overall control group (ASe-CON). This indicates that nutrient restriction, selenium intake, or the combination of the two, are altering eNOS expression. In the caruncular tissue, restricting intake and/or high selenium reduced eNOS expression. In the fetal placental tissues, eNOS expression in ASe-CON and ASe-RES ewes did not differ, whereas eNOS expression in HSe-CON ewes was reduced compared to both, indicating that selenium may play more of role in regulating eNOS expression in the cotyledon than nutrition. Selenoproteins have been shown to reduce reactive oxidative species, which includes nitric oxide; therefore, selenium may influence eNOS activity. Our laboratory is currently conducting further studies to investigate this hypothesis.

Our laboratory is also currently studying the offspring from ewe lambs used in a study similar to the ones described above to determine what long-term affects nutrient restriction and selenium may have on the health and productivity of the offspring. These studies have shown that post-natal physiology appears to be affected by both nutrient-restriction and selenium levels during pregnancy. Future studies involving the timing of restriction and realimentation in pregnancy are necessary in order to determine critical periods of adequate nutrition for proper fetal growth.

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Application of Laparoscopic Artificial Insemination Techniques to the North Dakota Sheep Industry

Justin S. Luther, Ph.D.

The small and tortuous nature of the cervical canal in sheep has made surgical or laparoscopic artificial insemination (LAI) the standard technique for AI in the U.S. sheep industry. However, considerable variation still exists when using this technique (conception rates from 10 to 85%). This report details our recent research efforts from NDSU and other institutions, and discusses our future research directions for further improving the LAI technique.

NDSU Department of Animal Sciences

Introduction

The primary goal of any artificial insemination (AI) program is to create better offspring. Laparoscopic AI is being used in the sheep industry around the world to extend the use of superior rams, and it offers the producer an opportunity to maximize the reproductive potential of his/her sheep. The primary economic benefit to the sheep producer is rapid infusion of valuable genetic traits into the flock.

Four primary factors will contribute to the success of any AI program:

1. Quality of the frozen semen being used;
2. Proper application of an appropriate estrous synchronization protocol;
3. Subsequent physiological "readiness" of the ewe being inseminated;
4. Precision of the laparoscopic AI technique.

Estrous Synchronization

Since LAI is a surgical procedure that requires equipment set-up and ewe preparation, all ewes must come into heat or estrus at a uniform point in time to make the procedure feasible. Synchronization of estrus involves inserting a sponge or CIDR device impregnated with progestogens. Both devices are left in place for 12-14 days and the progestogen is slowly absorbed into the ewe's blood stream. The progestogen inhibits follicle development on the ewe's ovary and prevents her from coming into heat or estrus. Once the device is removed, the progestogen level in her circulation will drop off and follicles will develop. At the time of removal, pregnant mare's serum gonadotropin (PMSG) or PG600 (a product which contains PMSG) is given to ensure follicle development and ovulation. Normally, 400 international units (IU) of PMSG are given, but if the procedure is being performed during the natural breeding season, less can be administered. If too much PMSG is given to the ewe, her ovulation rate will be too high and this may result in an excessive number of lambs born. Insemination should take place 50 to 60 hours after progestogen withdrawal.

Laparoscopic Artificial Insemination

All ewes are fasted and restricted access to water for 16 hours before the procedure. Ewes are injected with anesthesia 15 minutes before the procedure is performed. The ewe is placed on her back in a laparoscopy cradle. The abdominal region is surgically prepared by shearing the wool and disinfecting the skin. Using the cradle, the rear legs of the ewe are lifted to an approximate 45 degree angle (Figure 1). Two very small incisions are made in the skin of the abdomen to facilitate puncturing the abdominal wall with trocars. Once the abdominal wall is punctured, a laparoscope is placed through one of the cannulas into the abdominal cavity. The laparoscope contains a fiberoptic light, which permits the operator to view the ewe's reproductive tract. Carbon dioxide is used in the abdominal cavity to help visualize the uterus and seperate it from the abdominal wall. The less the reproductive tract

is manipulated, the better the conception rate. Once the uterus is in the correct position, an insemination pipette containing the semen is inserted. The operator then punctures the uterine horn and the semen is injected directly into the lumen of the uterus, and the same procedure is repeated on the other uterine horn. A minimum of 25 million motile sperm (100 µl volume) are deposited in each uterine horn. Once both horns have been inseminated, the cannulas are removed and a topical antibacterial spray is applied on the two small incisions. The entire procedure takes only 5 to 10 minutes. The incidence of infection because of this minor surgery is extremely low.

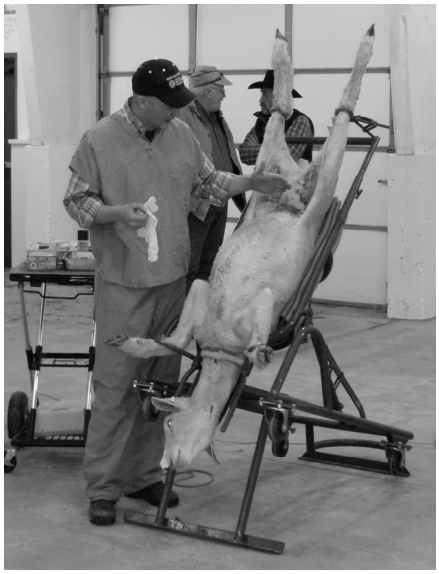

Figure 1. A ewe placed in the cradle and prepared for LAI.

Current Research Efforts at NDSU

As discussed above, the best method for synchronizing estrus or heat in a group of ewes involves treatment with intravaginal progestogens. Sponges generally contain synthetic sources of progesterone (medroxyprogesterone acetate), whereas CIDR devices contain natural sources of progesterone.

Neither of these products is commercially available in the U.S., although FDA approval of CIDR devices for use in sheep and goats is currently pending.

We have recently evaluated estrous response and pregnancy rate following laparoscopic AI in 129 ewes treated with Sponges or CIDR devices (Luther et al., 2007). The percentage of ewes displaying estrus or 'heat' after treatment with Sponges (88%) and CIDR devices (95%) did not differ. In addition, a high percentage of ewes became pregnant to laparoscopic AI in both groups (Figure 2). This study suggests that approval of CIDR devices by the FDA will provide us with a useful tool for estrous synchronization and laparoscopic AI in sheep.

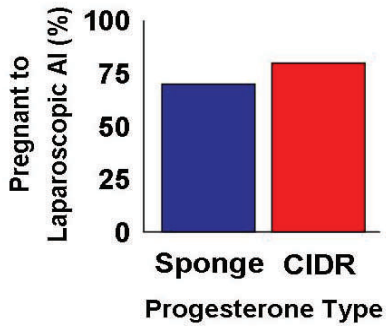

Figure 2. Similar pregnancy rates were achieved following synchronization with sponges or CIDRs.

Pregnant mare's serum gonadotropin (PMSG) is a product that is commonly injected at removal of a CIDR device or Sponge. PMSG helps to ensure that the release of an egg for fertilization or 'ovulation' occurs. We have recently shown that pregnancy rates are greater to laparoscopic AI when ewes are injected with PMSG (Figure 3, Luther et al., 2007).

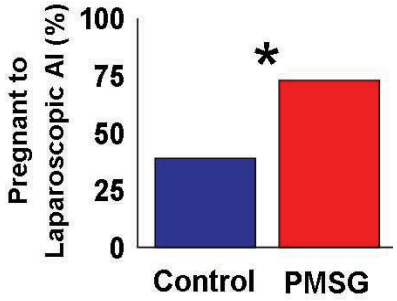

Figure 3. Injection of 400 IU of PMSG at progestogen removal increased pregnancy rates to LAI (Luther et al., 2007).

However, similar to the progesterone products, PMSG is not commercially available in the U.S. The latter has prompted us to investigate the alternative use of PG600. PG600 is a product that is commonly used in pigs and it contains both PMSG and hCG. Preliminary data, collected from only 35 ewes would suggest that relatively high pregnancy rates to laparoscopic AI are achieved when PMSG or PG600 is injected at removal of a CIDR device (Figure 4, Luther et al., unpublished).

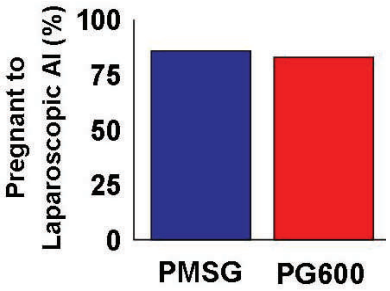

Figure 4. Injection of PMSG or PG600 at progestogen removal results in similar pregnancy rates to LAI (Luther et al., 2007)

These data support the use of a standard estrous synchronization protocol for laparoscopic AI utilizing products that will be, or currently are commercially available in the U.S. (Figure 5).

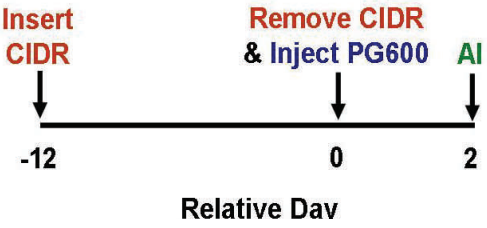

Figure 5. Standard estrous synchronization protocol developed for LAI in sheep.

Future Directions

Although we have achieved reasonable success with LAI in sheep. Additional research is still required to improve the technique. The results reported herein were gathered using sheep housed at NDSU in Fargo. In a

cooperating project between NDSU and sheep producers throughout the state we have achieved variable conception rates (10 to 85%). Thus far this project has found that:

- Considerable variability in conception rates occurs between farms;
- Season (AI in the Fall versus Spring) can greatly affects conception rates;
- Some variability may be explained by differences in semen quality.

Future studies will continue to evaluate the use of commercially available PG600 in place PMSG. The timing of ovulation relative to injection of these products is currently not known. Transrectal ultrasonography and repeated blood sampling techniques will be used to characterize physiological and hormonal events taking place after CIDR removal. These future studies are necessary for reducing between flock variability, and promoting long-term application in the ND sheep industry.