PROJECT ABSTRACT (250-400 words) Include

Problem or Opportunity

Reproductive efficiency and lamb crop weaned remain the biggest challenges to profitability and sustainability by sheep producers. Lambing rate across the U.S. averages about 107%; slightly lower in larger, range-based operations. Recent research has indicated a role of Anti-Mullerian hormone (AMH) in regulating and predicting ovarian follicular activity and longevity in peri-menopausal women. Other research has indicated a similar role of AMH in cattle. The available research is much more limited in sheep, but indicates there may be similarities.

Project Objectives

Objectives are to determine the possible role of Anti-mullerian hormone in relation to key reproductive functions in ewes - specifically: pregnancy rate and fecundity, puberty rate in ewe-lams, and lambing date. These are controlled at the brain / ovarian level. Secondly, to determine if AMH be could be predictive of reproductive longevity in older ewes. If Anti-Mullerian Hormone is predictive of pregnancy and/or fecundity in sheep, as well as possibly being associated with puberty and/or early conception, and/or longevity in older ewes, it could be used as a management and selection tool in flocks to improve reproductive efficiency.

Description of efforts – Anticipated results

Blood samples will be collected from mixed –age ewes in research flocks of Dorper and Rambouillet ewes. Hormone concentration will be compared with fertility, number of lambs born, and lambing date to determine if AMH can be used as a predictor of reproductive performance. Data will be analyzed to determine if breed, age, body weight and condition score of ewe are significant sources of variation of AMH. Results from this research will lead to a better understanding of the role of AMH in sheep. If AMH is a useful predictor of reproductive performance, its use may help the U.S. sheep industry to improve production efficiency by producing more lambs/ewe or by producing lambs earlier in the lambing season. Lambs that are born early will be older and heavier at weaning, and thus more valuable. Information about the breed difference is expected to be useful for producers and managers, as hair sheep have now surpassed fine wool sheep as the dominant breed-type in many areas, including Texas.
## GRANT BUDGET

### Amount requested from NSIIC

$4,537

### Applicant Matching Funds

#### Local/State/Federal Funds previously awarded for project

**TOTAL**

$4,537

### Type of Expenditure

<table>
<thead>
<tr>
<th>Personnel</th>
<th>Relationship to Project</th>
<th>Number of Hours</th>
<th>Rate of Compensation</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Bruce Carpenter</td>
<td>Principal Investigator</td>
<td></td>
<td></td>
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<tr>
<td>Dr. Dan Waldron</td>
<td>Co Principal Investigator</td>
<td></td>
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<tr>
<td>Dr. Scott Jaques</td>
<td>Co Principal Investigator</td>
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<td></td>
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</table>

### Materials and Supplies

<table>
<thead>
<tr>
<th>Reagents</th>
<th>Purpose</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Lab equipment</td>
<td>Blood analysis of AMH</td>
<td>$1,000</td>
</tr>
<tr>
<td>Reagents</td>
<td>Blood analysis of AMH</td>
<td>$2,000</td>
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### Travel

<table>
<thead>
<tr>
<th>Details</th>
<th>Number of Days</th>
<th>Number of Personnel</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic: Year 1</td>
<td>1800 mi @ $0.40</td>
<td>5</td>
<td>$720</td>
</tr>
<tr>
<td>Domestic: Year 2</td>
<td>Hotel @ $100</td>
<td>5</td>
<td>$500</td>
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### Other Related Expense

None

### Overhead

<table>
<thead>
<tr>
<th>Total Project Cost</th>
<th>Cost</th>
<th>7.5%</th>
<th>$317</th>
</tr>
</thead>
<tbody>
<tr>
<td>$4,537</td>
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<td></td>
<td></td>
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</tbody>
</table>
TECHNICAL OBJECTIVES
Responsiveness to NSIIC Stated Priorities (from web site)

Strengthen and improve long-term sustainability of the lamb and wool industry’s infrastructure by increasing the numbers in production.

Improvements in production efficiency are expected to lead to greater profitability and economic sustainability, which will lead to a greater numbers of ewes.

Prior USDA or other Federal Support

Not applicable. The project is not supported by current or pending federal support.

Identification and significance of the issue being addressed

Identification: Strengthen and improve long-term sustainability of the lamb and wool industry’s infrastructure by increasing the numbers in production.

Pertaining to the sustainability of the U.S. sheep industry, there are currently only about 5.2 million head of sheep in the U.S. (contrasted to the peak of 56 million in 1945). Improving reproductive efficiency is one way to address the issue of sustainable numbers in the national flock.

Materials and Supplies:
Recently a simple blood test for AMH in live animals has become available. We are requesting $3000 in grant funds to support the laboratory component of this research project. The purchase of reagents and associated assay supplies will be vital to successfully conducting and completing this research.

Travel:
A total of $1,220 is requested to cover state travel via car or truck at $0.40 per mile for 1800 miles.

Indirect Costs:
Costs are requested at the sponsor requested rate of 7.5% for a total of $317.
What are the goals to be achieved with this grant funding?

- To determine possible roles of Anti-mullerian hormone in regulating reproductive function in the ewe
- To further the body of knowledge regarding possible differences in reproductive longevity between Rambouillet vs. Dorper ewes, and to determine if Anti-mullerian hormone may be associated and/or predictive of this.
- Ultimately, to assess potential uses of Anti-mullerian hormone to manage selection for enhanced lamb production.

Work Plan – Task, Methodology, Individual responsible, and location where work will be done.

Hormone assays will be conducted by Dr. Scott Jaques, Texas Veterinary Medical Diagnostic Laboratory in College Station, Texas.

Sheep will be sampled and reproductive performance data will be collected at the Texas A&M Research and Extension Center in San Angelo by Drs. Dan Waldron and Bruce Carpenter.

The data will be analyzed by these three PIs and subsequently reported in appropriate venues.

Related Research or other efforts in this area of which you are aware, including an analysis of the competitive landscape if the award is for a commercial application.

Published research using ELISA technology for assay of peripheral blood for AMH in sheep, and its possible relation to fertility is limited to one paper (Lahoz, et al. Veterinary Research, 2012, 8:18). Our lab has similar, but yet unpublished data. Cambell et al. 2012 reported on direct sample of follicular fluid recovered from ewes post-mortem. Bézard, et al. 1987 reported detection of AMH in sheep ovaries post-mortem. Post-mortem sampling is both impractical and time-consuming. Recently, a simple blood test to detect AMH in live animals has become available.

Potential Post application in this area of development of research or commercial endeavor

If this research leads to the potential use of AMH measurement as a tool for managing reproductive performance in ewes, the potential might exist for commercial laboratories to offer AMH assay services. Their venture into this area would no doubt be contingent upon the development of a body of research knowledge that would support that endeavor.

Background and rationale (citation of publications if any)

AMH has been evaluated in mammalian follicles - including ovine follicles. The ELISA technology to measure it in ruminant blood has only recently become available (Beckman® or Ansh® assay). In 2012, the first and only data evaluating blood plasma were reported (Lahoz, et. al.), using the Beckman® assay. They were also the first and only group to evaluate and report on the relationship between AMH and fertility in the ewe. Our lab also has preliminary, yet unpublished assay/fertility data in ewes. The present proposed trial would add to this promising, yet small body of knowledge.
Relationship to industry, including technical, economic and social benefit

When trying to predict future reproductive potential, selection tools available to producers are currently limited to age and body weight in prepubertal ewe lambs, and in mature ewes, past production records - if they are available. Some of our unpublished data also indicates an advantage in reproductive longevity favoring Rambouillet vs. Dorper ewes. In the animal, reproductive functions are largely controlled by the neuro-endocrine system. Identifying the role of specific hormones (such as AMH) within this system offers the potential to development technologies which would allow measurement and thus management and selection for reproductive performance in ewes.

Cost benefit analysis

Having a useful predictor of future reproductive performance may lead to savings by identifying which ewe lambs should be kept as replacements. On the other end of life, AMH may indicate at what age individual ewes should be culled for age. A measure of AMH concentration could save feeding a ewe for an extra year, when a test could predict her chances of producing a lamb. Ewes with low probability of lambing could be sold at the start of the breeding season.

Policy or decisions affected by results

If AMH concentration in ewe lambs is shown to be effective at predicting future reproductive performance, producers could use an AMH test to decide which ewe lambs should be kept as replacements versus being sold. If AMH concentration in older ewes is shown to be effective at predicting future reproductive performance, producers could use an AMH test to decide which ewes should be culled versus kept another year. Currently many producers cull ewes of a certain age. The potential improvements from having a test that could predict reproductive success are that ewes with a greater chance of conceiving could be kept longer than average, while less productive ewes could be culled earlier than average.

Bio Sketch of each principal person

Bruce B. Carpenter, PhD, Professor and Extension Livestock Specialist. Ph.D. and M.S. Texas A&M, Physiology of Reproduction, B.S. New Mexico State University. Dr. Carpenter has been a faculty member at Texas A&M since 1994. He has authored 9 peer-reviewed journal articles, 26 abstracts, 79 Extension publications and 50 popular press articles. Extension activities include directing several state and regional level educational programs for livestock producers. He has also been an invited to be an international speaker, teacher and consultant for cattle and sheep in Mexico, the middle-east, and Zimbabwe.

Scott Jaques, PhD, Section Head for Endocrinology, Texas A&M Veterinary Medical Diagnostic Laboratory. PhD and M.S. Texas A&M, Physiology of Reproduction, B.S. Texas A&M. Dr. Jaques has been associated with this laboratory for 29 years. He has 41 peer-reviewed journal articles and 50 abstracts. He works with a variety of species ranging from coast pike fish to desert bighorn sheep, numerous exotics and all livestock species.

Dr. D.F. Waldron is a quantitative geneticist at Texas A&M AgriLife Research. He has conducted sheep and goat breeding research there since 1993. Dr. Waldron’s role in this project will be to oversee management of the ewes, maintain all production records, and obtain blood samples to submit to the lab.
The Board will score applications according to the criteria below, which are equally weighted in our review. Please comment on each aspect. (Refer to NSIIC’s the Strategic Plan for more info)

**FINANCIAL FEASIBILITY** (i.e., Is the budget proportionate to the endeavor, and will the outcome have a financial benefit to the industry in the near term or will additional funding be required?)

<table>
<thead>
<tr>
<th>The budget is proportionate to what will be required to complete laboratory assays by our research group. Again, this is preliminary research into a relatively new area. If results are positive, replication of those results would be needed with future funding required.</th>
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**BUSINESS SOUNDNESS** (i.e., Are project participants qualified and experienced)

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<tr>
<th>All three PI’s have successfully written and administered numerous research grants over their careers and are collaborating under Texas A&amp;M AgriLife Extension Service for the project. Texas A&amp;M AgriLife is a unique education agency with a statewide network of professional educators, trained volunteers, and county offices. It reaches into every Texas county to address local priority needs. AgriLife Extension demonstrates the latest technology and best practices to improve the state’s food and fiber system, which serves all Texas consumers and contributes nine percent of the gross domestic product.</th>
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**MANAGEMENT ABILITY** (i.e., Are project participants qualified and experienced)

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**POTENTIAL INDUSTRY IMPACT** (i.e., How can the industry be expected to benefit in both qualitative and quantitative measures?)

<table>
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<tr>
<th>Selection tools for reproductive performance are currently limited, in prepubertal ewes, to age and body weight. In mature ewes past production records are sometimes used - if they are available. Identifying the role of specific hormones (such as AMH) within the endocrine/reproductive system offers the potential to development technologies which would allow measurement and thus management and selection for improved reproductive performance in ewes.</th>
</tr>
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</table>
INDUSTRY SUPPORT (i.e., What data or other information is available to substantiate industry’s need or desire for this project?)

As U.S. sheep numbers have fallen, many industry producer groups, (for example the ASI “let’s grow program”) have advocated “increased production efficiency” as one way to help rebuild numbers and sustain an industry that has been in contraction for the last several decades. Research that leads to a better understanding of the endocrine factors that regulate reproduction could lead to future management options and selection tools. For example:
1) using new blood assay technology to measure AMH (not possible before 2012) to predict puberty, lambing rate and / or longevity in ewes and
2) Using AMH to better understand and manage breed differences which may exist in reproductive longevity.

CERTIFICATION

To the best of my knowledge and belief, all data in this application is true and correct. The document has been duly authorized by the governing body of the Applicant and the Applicant will comply with all Grant requirement if the assistance is awarded.

Signature S S  Katherine Kissmann  Date  10/15/15

Name of authorized representative: Katherine Kissmann

Title  Director, Sponsored Research Services

Internal Reference  SRS1601402

Email  BCarpent@ag.tamu.edu

Phone  432-336-8585

Return this application to: stevelee@nsiic.org
If you prefer to send hard copies:
Steve Lee,
Executive Director and Program Manager
National Sheep Industry Improvement Center
Box 646
Rockland, Maine 04841
207-236-6567

For FedEx or Other Delivery Services:
32 Gleason St
Thomaston, ME 04861
Download form to your computer, complete it and save it to your computer prior to submitting to the Sheep Center.
Additional Information for Applicants:

Matching funds:
In order to leverage funds available, NSIIC will assign 10 points to any application in which a match of cash or in-kind labor is contributed. In-kind matches may only account for 50% of the total match. Additionally, salaries or other expenditures that will be made by the applicant or the applicant's employer, irrespective of a potential grant award, cannot be used as a match.

A subtraction of 10 points will be made from the total score of any application that includes an overhead budget of more than 7.5% of the total grant request. Request for capital expenditures are discouraged, and may not exceed 20% of the total budget in any event. Please justify any requested funding for equipment or other capital expenditures.

Notification to Applicants: Applicants will be notified via e-mail that their application has been received within a day or two of receipt: After Review, all applicants will be sent a notice to the e-mail of the person listed as the contact person on the application. That notice will be one of three possible responses: 1) Your application did not score high enough for funding consideration 2) Your application scored high enough for funding as submitted 3) Your application scored high enough for funding but with modifications needed in the budget. You will be given the opportunity to make those modifications for funding or you may reject the modifications in which case the grant funding offer will be withdrawn. Instruction will be included in the notice. Please note that the Review Committee will not provide feedback to applicants however in some cases the Board may elect to encourage re submission with certain specific changes (i.e. those the Board feels were good causes but poor application preparation or those with a good idea but not sustainable as presented). In some instances the Board may want to provide a written statement, with the understanding that no further discussion is available. Please note that proposals submitted more than twice will not be evaluated. The NSIIC Board request that applicants refrain from communicating with Board Members specifically about the project (i.e. Lobbying your project). Under no circumstances will applications arriving past the deadline for submission be considered.