

SAES-422
Multi-state Activity Accomplishment Report

Project Number: S-299

Project Title: Enhancing Production and Reproductive Performance of Heat-Stressed Dairy Cattle

Period Covered: January, 2002 to January, 2003

Date of This Report: March 18, 2003

Annual Meeting Dates: January 31 – February 1, 2003

Participants (S-299 members present and/or submitting reports/correspondence of activities):

S-299 2002 Officers Present:

Bruce Jenny	LA	Guest S-299 Administrative Advisor (for D. Morrison)
Deb Hamernik	USDA-CSREES	S-299 USDA-CSREES Representative
Scott Willard	MS	S-299 Chair
Joe West	GA	S-299 Chair-Elect
Terry Smith	MS	S-299 Secretary

Participant Members Present:

Bob Godfrey	USVI-St. Croix	Chris Wildman	GA*
Jerry Ward	LA	Logan Evans	MS*
Lannett Edwards	TN	Susan Bowers	MS*
Scott Whisnant	NC	Stephanie Schmidt	MS*
		Justin Williams	MS*
		Tim Dickerson	MS*

Participant Members Not Present, but Reports or Correspondence of Activities Submitted:

Peter Hansen	FL	Steve Washburn	NC
Ellen Jordan	TX	James Spain	MO
Keith Cummins	AL	Wayne Kellogg	AR

*Guests - Graduate Students in attendance

Summary of Annual Meeting Minutes:

The meeting began at 3:00 PM on January 31st with self-introductions by the meeting participants. Administrative comments regarding S-299 activities, Multi-state reporting and federal initiatives were made by B. Jenny (S-299 guest AA for D. Morrison), and D. Hamernik (USDA-CSREES representative). The S-299 business meeting was convened in which the previous year's minutes and annual report were approved unanimously. J. Ward (LA) was nominated and volunteered to serve as the S-299 Secretary for the coming year (J. West will be

Chair and T. Smith will move to Chair-Elect). Those members that were in attendance all presented station reports and updates of research and collaborative arrangements. A decision was made to meet next year in Tulsa, OK on February 14 & 15, 2004 starting at 1:00 pm on Friday the 14th in conjunction with the Southern Section Animal Science meetings. The members also voted unanimously to hold the 2005 S-299 meetings in the US-Virgin Islands and to tour their research station. A date in April was suggested to minimize air and hotel rates and it was decided to invite to W-173 “Animal Stress” group to join S-299 for a joint meeting. Following a tour of the LSU Dairy Facilities and documentation of collaborative arrangements for the coming year, the meeting was adjourned at 4:30 PM on February 1st.

Accomplishments and Impacts:

Note that the principal reporting investigator and their location is indicated in relation to the stated accomplishment and subsequent impact. However, in almost all cases these are multi-state collaborative projects that involve one or more S-299 participants. This is reflected in the “List of Publications” and “Plans for the Coming Year” sections that follow the “Accomplishments and Impacts”.

Objective I:

A. Effect of environmental stressors on body temperature, nutrient intake, and performance.

- ◆ **Accomplishment:** Studies were conducted to evaluate cow body temperatures over a 24-hr period in response to heat stress, and to investigate the effectiveness of various management techniques in abating heat stress as indicated by body temperature (**West – GA**). Using a novel tympanic membrane probe to monitor cow body temperature, dynamic fluctuations in body temperature were recorded remotely to document 24-hr changes and responses to heat stress and cooling strategies. **Impact:** Novel methods for charting body temperature in lactating dairy cows during heat stress will provide improved methodologies to assess the effectiveness of cooling strategies in mediating or abating heat stress in dairy cows.
- ◆ **Accomplishment:** Temperatures of bedding materials were measured weekly during late summer (August to October, 2002) when high temperatures averaged 32.1° C outside and 29.9° C inside the calf barn that was open on three sides (**Kellogg – AR**). Mean temperatures of sand (26.4° C) and granite fines (25.6° C) were cooler than other materials studied. Wheat straw was warmest (27.8° C), while rice hulls (26.9° C) and wood shavings (27.0° C) were intermediate in temperature. Straw provided the softest surface, and sand and granite fines were the hardest surfaces. The types of bedding did not affect behavior or growth performance of calves; however calves on granite fines were dirtier and calves on wood shavings were cleaner compared to the other three beddings. **Impact:** Granite fines (used for manufacturing asphalt shingles) and sand were cooler bedding materials for calves, but also provided the hardest surfaces and calves on granite fines were dirtier than calves on other bedding materials. Granite fines and rice hulls are less inexpensive bedding materials than sand, wood shavings, and wheat straw for dairy calves.

B. Effect of climate pre- and postpartum on intake and performance.

- ◆ **Accomplishment:** The metabolic demands of milk production can compound the effects of heat stress and negatively impact metabolic processes and production performance in lactating dairy cows. A study was performed to determine whether type of cooling system (fan vs. fan and sprinkler) may influence production performance and body composition quality traits in lactating dairy cattle (**Willard – MS**). Results indicated clear differences between high and low milk production groups in body composition traits, however cooling strategy did not influence these parameters within milk production groups. Cooling did, however, reduce heat stress as indicated by rectal temperatures, dorsal infrared body surface temperature measurements and respiration rate. **Impact:** Dairy producers have a vested interest in techniques for increasing profitability and improving management techniques. This study provides a possible technique through assessments of body compositional traits for evaluating body energy reserves in dairy cattle. These data also demonstrate the advantages of using cooling strategies for alleviating heat stress in lactating dairy cows.

C. Effect of environmental stressors on reproductive performance.

- ◆ **Accomplishment:** Reduced developmental competence of heat-shocked oocytes after the resumption of meiosis may be due to alterations in nuclear or cytoplasmic maturation. Current research is focused on examining cortical granule types and the nuclear stage of bovine oocytes matured at an elevated temperature to evaluate the effects of heat stress on oocyte competence (**Edwards – TN**). Results thus far have shown a reduced developmental competence of heat-stressed oocytes which may be due to specific alterations occurring in the cytoplasm during maturation. **Impact:** Gaining a further understanding of the negative effects of heat stress at the cellular and molecular level will be critical for development of novel strategies for improving reproduction and embryonic survival during heat stress.
- ◆ **Accomplishment:** Two-cell embryos are among the embryos most susceptible to elevated temperature (heat shock). Experiments are being conducted to determine ultrastructural changes in two cell embryos exposed to elevated temperature (**Hansen – FL**). Findings indicate that exposure of 2-cell bovine embryos to elevated temperatures can disrupt embryonic development by causing alterations in the cytoskeleton, cytoplasm, nucleus and mitochondria. **Impact:** Though a greater understanding of the effects of heat stress on the ultrastructure of the developing embryo, we may better understand how elevated temperatures may compromise the establishment of pregnancy.
- ◆ **Accomplishment:** An experiment was performed to test whether heat shock causes similar changes in embryos produced *in vivo*. The specific objectives were to 1) evaluate effects of a physiological heat shock on the ultrastructure of 2-cell bovine embryos produced *in vivo* and heat shocked *ex vivo*, 2) compare the ultrastructural morphology of *in vitro* vs. *in vivo* produced 2-cell embryos, and 3) determine the content of the cytoplasmic vesicles (**Hansen – FL**). Findings indicate that exposure of *in vivo* produced 2-cell bovine embryos to elevated temperatures causes disruption in ultrastructural morphology that are inimical to development. **Impact:** The observation that overall morphology and response to heat stress

was similar to what has been reported for *in vitro* embryos implies that the latter can be a good model for understanding embryonic responses to heat shock.

- ◆ **Accomplishment:** Heat shock, which can compromise development of preimplantation bovine embryos, also increases the percentage of blastomeres that may undergo apoptosis and increases activity of group II caspases (i.e., caspase-2, -3, and -7). It is hypothesized that apoptosis is important for the removal of damaged blastomeres and beneficial to the continued development of the embryo after heat shock. To test these hypotheses the effects of an inhibitor of group II caspases on were evaluated (**Hansen – FL**). Findings indicate that group II caspases mediate heat-induced apoptosis in bovine embryos. Moreover, inhibition of these caspases has a detrimental effect on embryonic resistance to heat shock. Taken together these results implicate apoptosis as an adaptive mechanism to allow the embryo to survive and develop following exposure to stress. **Impact:** An enhanced understanding of how the embryo responds and overcomes a heat-induced response is critical toward developing systems that may increase embryo survival during heat stressed conditions.

D. Effect of genetic selection on heat tolerance or intolerance.

- ◆ **Accomplishment:** Studies have addressed the interaction between coat color (black versus white percentage) and heat stress on thermal heat load in dairy cattle (**Godfrey – USVI**). These studies have identified advantages in dairy cattle with a greater percentage of white hair-coat relative to their thermal tolerance. **Impact:** The higher rectal temperatures found in dark heifers suggests that selection for white coat color may be useful in mitigating the effects of heat stress in dairy cattle in hot climates.
- ◆ **Accomplishment:** A long-term goal is to identify genes controlling cellular thermotolerance and transfer these genes into Holstein cattle to reduce the magnitude of deleterious effects of elevated temperature on embryonic survival, immune function, and other aspects of physiological function in cattle. As part of this effort, a survey of genotypes expressing increased tolerance to heat shock at the cellular level is underway. Recently, an experiment was conducted to evaluate genetic differences in cellular thermotolerance extended to the Romosinuano, a *Bos taurus* developed in Colombia from the first European cattle brought to the New World (**Hansen – FL**). These results demonstrate that embryos from thermotolerant breeds (Brahman and Romosinuano) are more resistant to elevated temperature than embryos from a thermosensitive breed (Angus). Thus, the process of adaptation of Brahman and Romosinuano breeds to hot environments resulted in both cases in selection of genes controlling thermotolerance at the cellular level. In a separate study, the production performance the genotypic differences in Gir (*Bos indicus*) x Holstein and Holstein cattle are also being evaluated (**Willard – MS**). **Impact:** The identification of the specific genes involved in thermotolerance among breeds could lead to novel ways to increase resistance of cattle to heat stress.

E. Effect of heat stress and production level on endocrine profiles.

- ◆ **Accomplishment:** Studies are on-going examining the hormonal profiles of Holstein cows from calving through the postpartum period for cows in summer versus winter (**Whisnant –**

NC). Results thus far have shown that cows calving during the summer have a longer interval to first ovulation than those calving during the winter, and that serum thyroid concentrations are higher in winter calving cows than in summer calving cows for the first 8 weeks postpartum. The reduced thyroid concentrations in heat stressed dairy cattle during early lactation may be directly associated with a delay in first postpartum ovulation. **Impact:** Through an enhanced understanding of the endocrine profiles during heat stress in the postpartum cow, we may better understand how to target environmental modification strategies or overcome the detrimental effects of heat stress on hormonal processes in dairy cattle. Additional analysis for insulin, glucose, cortisol, cholesterol, plasma urea nitrogen, nonesterified fatty acid and leptin concentrations are being conducted currently and should yield additional information of value in elucidating the multi-factorial effects of heat stress on the endocrine system.

Objective II:

- A. Effect of nutritional strategies to enhance intake and efficiency of nutrient utilization and improve reproduction in hot, humid climates.
- ◆ **Accomplishment:** Studies have addressed the influence of various types of nutritional supplementation (e.g., yeast culture; **Ward – LA**) during the transition period in dairy cattle, and will be further examined in the context of heat stress. **Impact:** Through dietary manipulation the effects of heat stress may be abated to some extent, and through using targeted nutritional supplementation production performance may be improved.
 - ◆ **Accomplishments:** Experiments were conducted to test whether enhancement of antioxidant status could improve fertility and milk yield in dairy cows and resistance of cultured embryos to heat shock (**Hansen – FL**). In summary, multiple injections of vitamin E and selenium did not improve postpartum fertility or milk yield of lactating Holstein cows and there was no direct thermoprotective effect of culturing heat-shocked embryos with vitamin E. **Impact:** Vitamin E was not found to be beneficial to postpartum cow performance or in the survivability of heat-shocked embryos, therefore should not be recommended until further research can be conducted.
 - ◆ **Accomplishment:** The relationship between dietary cation-anion difference (DCAD) and dietary crude protein (CP) in the heat-stressed lactating dairy cow was investigated to determine if changes in protein metabolism occur as a result of including cationic salts in the lactating cow total mixed ration (**West – GA**). The relationship was examined at DCAD of 25 and 50 meq/100 g DM combined with CP levels of 15 and 17%. Results indicate a relationship exists between DCAD and protein metabolism. High DCAD resulted in lower average daily milk yields at high CP level when compared to low DCAD high CP diets. A relationship was also observed in blood and urine Na levels. At low CP, blood Na decreased with increasing DCAD. At high CP, blood Na increased with increasing DCAD. In addition, a more dramatic increase in fractional excretion of Na was observed at low CP with increasing DCAD relative to the increase observed with the high CP diet. **Impact:** A better understanding of the effect of acid-base balance on protein metabolism will enhance the

effectiveness with which the protein needs of the heat-stressed cow are met at reduced intake levels that occur as a result of heat-stress.

B. Effect of hormonal supplements to enhance reproductive performance in hot, humid climates.

- ◆ **Accomplishment:** Studies have been conducted in a collaborative effort among three stations (**Godfrey – USVI; Whisnant – NC; Willard – MS**) to evaluate the effects of supplemental GnRH administration post-breeding on endocrine profiles and pregnancy rates in heat stressed dairy cows and heifers. While somewhat variable results have been obtained among these studies to date with respect to pregnancy rates, further analysis is continuing to determine whether such a hormonal therapy would be advantageous during heat stress as the endocrine profiles of the treated cows suggests marked improvement of their hormonal status post-breeding. **Impact:** Should treatment with GnRH post-breeding prove effective for improving fertility in heat-stressed dairy cows, this practice could be easily implemented by producers at very low cost (less than \$5 per cow).
- ◆ **Accomplishments:** Administration of bovine somatotropin (bST) improves pregnancy rates following timed artificial insemination in lactating dairy cows. Two experiments tested whether bST administration to non-lactating recipients improves pregnancy rates following transfer of *in vitro* produced embryos (**Hansen – FL**). Results indicate that breed of recipient but not bST administration affects pregnancy rates in non-lactating recipients following timed embryo transfer with IVP embryos. **Impact:** Understanding the interactions between breed of embryo transfer recipient and the effects of bST administration on pregnancy rates is a critical for improved reproductive performance and reproductive management strategies for dairy cows.

C. Effect of environmental modification strategies on lactational and reproductive performance in hot, humid climates.

- ◆ **Accomplishment:** One controversial cooling method for managing heat stress is the utilization of cooling ponds. A survey was sent to Texas dairy producers who might have cooling ponds, and general information regarding the use of the cooling ponds was collected along with milk quality information (**E. Jordan – TX**). Results indicated that for the major pathogens the presence or absence of a cooling pond did not influence the number of organisms identified. From these results, the use of cooling ponds does not increase bacterial populations in bulk tank milk samples. The herds examined with cooling ponds produced 2.62 kg of milk/milking cow/day more in August than did herds without cooling ponds. Herds with cooling ponds also produced more milk in June, July, September and October than herds without cooling ponds. No differences were founded in culling patterns between the two groups. **Impact:** Cooling ponds may represent an effective method for improving production performance during heat stress in some regions, and results indicate that bacterial loads in milk were not increased as might be expected. Such cooling strategies may provide producers with alternate cooling options than traditional fan and sprinkler methods.

- ◆ **Accomplishments:** A lactation trial was performed to characterize the impact of tunnel ventilation cooling and diet on symptoms of heat stress in dairy cows (**Smith – MS**). Average exposure time to conditions of moderate heat stress was reduced 6.75 h/day for cows housed in the tunnel ventilation barn and maximal daytime rectal temperatures for cows housed inside averaged 0.28°C below those for cows housed outside. Furthermore, the maximal daytime respiration rate averaged 6.0 breaths/min lower for cows housed inside the tunnel barn than for cows housed outside. These results demonstrate that barns equipped with tunnel ventilation can be helpful in reducing the severity of heat stress on dairy cows in the southeastern U.S. **Impact:** Understanding the basic biology of heat stress in dairy cows is crucial to overcoming its effects. This research identifies specific management and nutritional strategies to mitigate the impact of heat stress on dairy production.

Plans for the Coming Year – Established Collaborations and On-going Projects:

- ◆ Whisnant (NC), Willard (MS) and Godfrey (USVI) – Supplemental GnRH administration post-breeding in the heat-stressed dairy cow. (Objective 2B)
- ◆ Godfrey (USVI – Lead Institution), Whisnant (NC), West (GA), Ward (LA), Willard (MS) and other institutions in the project – Coat Color Analysis, stations will Godfrey (USVI) low resolution JPEG images (cows left and right views) for analysis as part of all studies conducted this summer. (Objective 1A).
- ◆ Willard (MS), Edwards (TN) and Godfrey (USVI) – Intravaginal and Intrauterine temperatures of heat stressed dairy cattle. (Objective 1A).
- ◆ Smith (MS) and Ward (LA) – Tracking cow performance as heat increases in relation to dietary nutritional supplementation. (Objective 2A).
- ◆ Smith (MS) and Ward (LA) – Dietary Yeast and Fibrozyme supplementation effects on heat-stressed dairy cows. (Objective 2A).
- ◆ Smith (MS) and Ward (LA) – Effects of Tunnel Ventilation housing on heat stress abatement. (Objective 2C).
- ◆ Ward (LA), Bernard (GA) and West (GA) – Cooling prepartum and transition cows. (Objective 1B).
- ◆ Whisnant (NC) and West (GA) – Heat stress on endocrine profiles. (Objective 1E).
- ◆ West (GA) – Effect of management practices on body temperatures (Objective 1A)
- ◆ West (GA) – Effect of dietary DCAD and N. (Objective 2A).

List of Publications:

Refereed Journals and Peer-Reviewed Proceedings:

Al-Katanani, Y.M., Paula-Lopes, F.F., and Hansen, P.J. (2002) Effect of season and exposure to heat stress on oocyte competence in Holstein cows. *J. Dairy Sci.* 85, 390-396.

Al-Katanani, Y.M., Rivera, R.M., and Hansen, P.J. (2002) Seasonal variation in development of in vitro produced bovine embryos. *Vet. Rec.*, 150, 486-487.

Al-Katanani, Y.M., and Hansen, P.J. (2002) Induced thermotolerance in bovine two-cell embryos and the role of heat shock protein 70 in embryonic development. *Mol. Reprod. Dev.* 64, 174-180.

Al-Katanani, Y.M., Drost, M., Monson, R.L., Rutledge, J.J., Krininger III, C.E., Block, J., Thatcher, W.W., and Hansen, P.J. (2002) Pregnancy rates following timed embryo transfer with fresh or vitrified in vitro produced embryos in lactating dairy cows under heat stress conditions. *Theriogenology* 58, 171-182.

Block, J., Chase, C.C., Jr., and Hansen, P.J. (2002) Inheritance of resistance of bovine preimplantation embryos to heat shock: relative importance of the maternal vs. paternal contribution. *Mol. Reprod. Dev.* 63, 32-37.

Block, J., Drost, M., Monson, R.L., Rutledge, J.J., Rivera, R.M., Paula-Lopes, F.F., Ocon, O.M., Krininger, C.E. III, Liu, J., and Hansen, P.J. (2003) Use of insulin-like growth factor-1 during embryo culture and treatment of recipients with GnRH to increase pregnancy rates following the transfer of in vitro produced embryos to heat-stressed, lactating cows. *J. Anim. Sci.*, (accepted).

Dorado, C.M., L.M. McCann, J.A. Miller and J.L. Edwards. 2001. Nuclear status of bovine oocytes exposed to elevated temperature after resumption of meiosis. *Theriogenology* 55(1):469.

Edwards J.L., W.A. King, S.J. Kawarsky and A.D. Ealy. 2001. Responsiveness of early embryos to environmental insults: Potential protective roles of HSP70 and glutathione. *Theriogenology* 55(1):209-224.

Hansen, P.J. (2002) Embryonic mortality in cattle from the embryo's perspective. *J. Anim. Sci.* 80 (E. Suppl. 2): E33-E44.

Jordan, E.R., T. Hickerson, and M. Tomaszewski. 2003. Evaluation of the effects of cooling ponds on bacterial population in bulk tank milk samples. Proc. of the 42nd National Mastitis Council Conference. p. 316-317.

Krininger, C.E. III, Stephens, S.H., and Hansen, P.J. (2002) Developmental changes in inhibitory effects of arsenic and heat shock on growth of preimplantation bovine embryos. *Mol. Reprod. Dev.* 63:335-340.

Krininger III, C.E., Block, J., Al-Katanani, Y.M., Rivera, R.M., Chase, C.C., Jr., and Hansen, P.J. (2003) Differences between Brahman and Holstein cows in response to estrous synchronization, superovulation and resistance of embryos to heat shock. *Anim. Reprod. Sci.*, (in press).

Moreira, F., Paula-Lopes, F.F., Hansen, P.J., Badinga, L., and Thatcher, W.W. (2002) Effects of growth hormone and insulin-like growth factor-I on development of in vitro derived bovine embryos. *Theriogenology*, 57, 897-905.

Paula-Lopes, F.F., and Hansen, P.J. (2002) Heat-shock induced apoptosis in preimplantation bovine embryos is a developmentally-regulated phenomenon. *Biol. Reprod.*, 66, 1169-1177.

Paula-Lopes, F.F., and Hansen, P.J. (2002) Apoptosis is an adaptive response in bovine preimplantation embryos that facilitates survival after heat shock. *Biochem. Biophys. Res. Commun.* 295, 37-42.

Paula-Lopes, F.F., Chase, C.C., Jr., Al-Katanani, Y.M., Krininger, C.E. III, Rivera, R.M., Tekin, S., Majewski, A.C., Ocon, O.M., Olson, T.A., and Hansen, P.J. (2003) Genetic divergence in cellular resistance to heat shock in cattle: Differences between breeds developed in temperate versus hot climates in responses of preimplantation embryos, reproductive tract tissues and lymphocytes to increased culture temperatures. *Reproduction* **125**, 285-294.

Paula-Lopes, F.F., Al-Katanani, Y.M., Majewski, A.C., McDowell, L.R., and Hansen, P.J. (2003) Manipulation of antioxidant status fails to improve fertility of lactating cows or survival of heat-shocked embryos. *J. Dairy Sci.*, in press.

Rivera, R.M., Kelley, K.K., Erdos, G.W., and Hansen, P.J. (2002) Heat shock induces ultrastructural changes in two-cell bovine embryos. *The Beam* 18 (1): 11-19.

Rivera, R.M., Kelley, K.K., Erdos, G.W., and Hansen, P.J. (2002) Heat shock induces ultrastructural changes in two-cell bovine embryos. *Proc. Ann Mtg. Southeastern Microscop. Soc.*, p 11.

Willard, S., S. Gandy, S. Bowers, K. Graves, A. Elias and C. Whisnant. 2003. The effects of GnRH administration post-breeding on serum concentrations of progesterone and pregnancy rates in dairy cattle exposed to mild summer heat stress. *Theriogenology* 59(8): 1799-1810.

Meeting Abstracts and Experiment Station Reports:

Block, J., Drost, M., Monson, R.L., Rutledge, J.J., Rivera, R.M., Paula-Lopes, F.F., Ocon, O.M., and Hansen, P.J. (2002) Use of insulin-like growth factor-1 in culture and administration of GnRH to recipients to improve pregnancy rates following timed embryo transfer of in vitro-produced embryos to lactating dairy cows. *J. Anim. Sci.* 80 (Suppl. 1), 78 (abstr.).

Block, J., Chase, C.C., and Hansen, P.J. (2002) Inheritance of resistance of bovine preimplantation embryos to heat shock: relative importance of the maternal versus paternal contribution. *Biol. Reprod.* 66 (Suppl. 1): 154 (abstr.).

Block, J., Monson, R.L., Rutledge, J.J., Rivera, R.M., Paula-Lopes, F.F., Ocon, O.M., Rosson, H., Al-Katanani, Y.M., and Hansen, P.J. (2003) Effect of bovine somatotropin, breed, and circulating progesterone concentrations at the time of transfer on pregnancy rates following timed embryo transfer in non-lactating cows. *J. Anim. Sci.*, submitted (abstr.).

Evans, H.L., S.T. Willard, B.J. Boyd and R.C. Vann. 2002. Dynamic changes in body composition quality traits as influenced by sampling interval in beef heifers. 2001 Central Mississippi R & E Progress Report.

Gandy, S., S. Bowers, K. Graves, A. Elias, S. Willard and C. Whisnant. 2002. Administration of GnRH post-breeding improves pregnancy rates and increases serum concentrations of progesterone during heat stress in dairy cattle. ASAS Southern Section Meetings, Orlando, FL – February 1 – 6, 2002; Abstract 66 – pg. 17.

Godfrey, R.W., R.E. Dodson, A.J. Weis and O.T. Isles. 2003. The effect of using of Ovsynch with supplemental GnRH on pregnancy rates of Holstein heifers in the tropics. Submitted to 2003 National Animal Science meeting, Phoenix, AZ (*Accepted / To be Presented*).

Godfrey, R.W., O.T. Isles, A.J. Weis and R.E. Dodson. 2003. The effect of hair coat color on rectal and surface temperatures of Holstein heifers in the tropics. Submitted to 2003 National Animal Science meeting, Phoenix, AZ (*Accepted / To be Presented*).

Nordbladh, L.I., A.E. Sweetman and C.S. Whisnant. 2003. Effect of season on serum thyroxine and beta-hydroxy butyrate concentrations in early postpartum dairy cows. Submitted to 2003 National Animal Science meeting, Phoenix, AZ (*Accepted / To be Presented*).

Paula-Lopes, F.F., and Hansen, P.J. (2002) Administration of the caspase inhibitor, z-DEVD-fmk, to bovine preimplantation embryos blocks heat-induced apoptosis and increases embryonic sensitivity to heat shock *Biol. Reprod.* 66 (Suppl. 1): 105 (abstr.).

Panivivat, R., Kegley, E.B., Kellogg, D.W., Pennington, J.A. VanDeveder, K., Hellwig, D.H., Wistuba, T.J., and Krumpleman S.L. 2002. Preference for and bacterial counts in sand and granite fines as bedding for lactating cows. University of Arkansas Agric. Exp. Sta. Res Series 499. Pages 143-146.

Payton R.R., J.L. Lawrence, A.M. Saxton, J.R. Dunlap, and J.L. Edwards. 2002. Cortical granule types and nuclear stage of bovine oocytes after exposure to elevated temperature during maturation. (Abstract accepted for publication at International Embryo Transfer Society Meetings to be held in Auckland, New Zealand, January 11-15, 2003).

Rivera, R.M., Kelley, K.L., Erdos, G.W., and Hansen, P.J. (2003) Exposure of in vivo produced 2-cell bovine embryos to a physiological-relevant heat shock results in alterations to the ultrastructural morphology. *Biol. Reprod.*, submitted (abstr.).

Rivera, R.M., Kelley, K.K., Erdos, G.W., and Hansen, P.J. (2002) Heat shock induces ultrastructural changes in two-cell bovine embryos. *Biol. Reprod.* 66 (Suppl. 1): 158-159 (abstr.).

Smith, T.R., S. Willard, A. Chapa, T. Riley and D. Pogue. 2002. The impact of tunnel ventilation on heat stress in lactating dairy cows: Effect on body temperature, respiration rate and milk production. 2001 North Mississippi R & E Progress Report.

Smith, T.R., S. Willard, A. Chapa, R. J. Williams, T. Riley, and D. Pogue. 2002. The impact of tunnel ventilation on heat stress in lactating dairy cows: Effects on intake, milk production and composition. *J. Dairy Sci.* 85 (Suppl. 1): Abstr. 1236.

Smith, T. R., S. Willard, A. Chapa, T. Riley, and D. Pogue. 2002. The impact of tunnel ventilation on heat stress in lactating dairy cows: Effects on body temperature and respiration rate. *J. Ani.Sci.* 80(Suppl. 2): Abstr. 98.

Sweetman, A.E., L.I. Nordbladh, and C.S. Whisnant. 2003. Effect of administration of GnRH on day 5 or day 5 and 11 post-insemination on pregnancy rates and serum progesterone concentrations of lactating dairy cows during different seasons. Submitted to 2003 National Animal Science meeting, Phoenix, AZ (*Accepted / To be Presented*).

Tomaszewski, M.A., M.A. de Haan, J.A. Thompson, and E.R. Jordan. 2003. The impact of cooling ponds in north central Texas on milk production and culling. *J. Dairy Science* - abstr. (*submitted*).

Ward, J. D. 2002 .The effects of supplementing yeast culture during the transition period on performance of Holstein cows during hot humid weather. *J. Dairy Sci.* 85 (suppl. 1):119.

Willard, S.T. and E.J. Murphy. 2002. Economic and Production Differences Between Large and Small Holstein Cows Cooled with Fans and Sprinklers or Fans Only. 2001 Central Mississippi R & E Progress Report.

Williams, R., A. M. Chapa, T. O. Riley, D. E. Pogue, S. T. Willard and T. R. Smith. 2003. The impact of tunnel ventilation cooling and bmr corn silage on heat stress in lactating dairy cows. North MS Res. & Ext Center Annual Report. p. 191.

Administrative Advisor Authorization:

David Morrison (LA)

Date