INTRODUCTION: The major issue facing the Southeast (SE) agricultural industry in the US is the sustainability of the region's dairy farm operations. Indeed, if this dire situation is not ameliorated, milk production is forecasted to decline by 35% in the SE in the next 15 yr, whereas overall US production will increase by 23%, lowering the competitiveness of the SE states (Herndon, 2011). Moreover, from 1995-2010, the SE experienced a 64% decline in the number of dairy farms (from 9,297 to 3,380; **Table 1**). AL, AR, LA, MS, KY, and TN lost the most farms (66-81%). Over this same period, the SE lost 47% of its dairy cow population (**Table 1**), with AL, AR, LA, MS, KY, and TN losing the most cows (52-80%). Such reductions in dairy operations as well as in cow populations question the long-term sustainability of the SE industry.

Table 1. Changes in the number of dairy farms and dairy cows in the SE from 1995-2010 (Data from USDA Statistics).

	----------Number of dairy farms----------					------Number of dairy cows (1000s)------				
					% change					% change
State	**1995**	**2000**	**2005**	**2010**	**95-2010**	**1995**	**2000**	**2005**	**2010**	**95-2010**
Alabama	246	154	90	60	76	34	25	16	11	68
Arkansas	693	427	210	130	81	60	39	22	12	80
Florida	300	231	180	140	53	162	157	137	114	30
Georgia	536	404	320	260	52	100	88	81	78	22
Kentucky	2,731	1,932	1,335	940	66	162	132	106	78	52
Louisiana	646	468	280	150	77	76	58	35	20	74
Mississippi	515	356	234	130	75	55	36	25	17	69
N. Carolina	683	447	365	290	58	86	71	54	44	49
S. Carolina	178	116	110	85	52	27	23	18	16	41
Tennessee	1,544	999	710	490	68	127	95	70	52	59
Virginia	1,225	998	815	705	42	129	120	105	95	26
Total	**9,297**	**6,532**	**4,649**	**3,380**	**64**	**1,018**	**844**	**669**	**537**	**47**

A recent trend analysis of the future status of the SE dairy industry also points to the distressed economic health and profitability of dairy farms in this region (Herndon, 2011). For example, the SE realized a 37% *decline* in milk production from 1995-2010, while nationally, the US experienced a 24% *increase* in production. Likewise, although the SE realized a 13% increase in milk production per cow from 14,000 lb in 1995 to 15,840 in 2010, this production increase in the US overall was 29%; increasing from 16,400 to 21,150 lb. By focusing on milk production per farm as a barometer of profitability, the sustainability of SE herds is further brought into question; specifically, from 1995 to 2010, the SE realized only a 51% increase in output per farm, whereas output for the US increased 3-fold or by 161%!

Further examination of the facts brings the true productivity of SE dairy farms into focus. **Table 2** illustrates the test day milk production and somatic cell counts (SCC) values in SE herds enrolled in the Dairy Herd Improvement (DHI) Program from 2001-2010 (USDA/ARS Animal Improvement Program Laboratory reports on somatic cell counts of milk from DHI herds from 2001 – 2010). The 10-yr SE average production was 13% less than the national average (61.3 vs. 70.8 lb). Other data show that while average US production increased by 3.7 lb/day, the SE average increase was only 1.5 lb/day; 50% as much; 3 states actually realized a decrease in daily

yield. Clearly, the SE needs to enhance the profitability of its dairy industry if this region is to be sustainable and remain competitive with the rest of the Nation.

Table 2. Test day milk production and SCC in SE DHI program herds program from 2001-2010.

	----------Milk production (lb/day)--------						--------Somatic cell count (1000s)----------					
State	**2001**	**2003**	**2005**	**2007**	**2010**	**Avg.**	**2001**	**2003**	**2005**	**2007**	**2010**	**Avg.**
AL	51.8	51.4	51.5	50.6	48.5	51.1	444	517	433	407	415	445
AR	51.7	56.7	58.4	55.1	53.0	55.3	486	387	448	441	421	433
FL	66.3	67.4	72.9	69.0	68.6	68.8	548	633	473	333	274	421
GA	62.8	60.6	63.1	61.2	64.0	62.5	407	479	433	422	337	406
KY	59.4	60.8	65.0	63.3	65.2	62.8	413	419	392	354	313	375
LA	53.9	55.1	55.1	51.2	53.8	54.1	479	498	416	446	380	450
MS	60.4	63.2	64.1	64.9	62.9	63.1	442	480	386	337	290	388
NC	66.9	66.0	66.8	68.2	66.2	66.7	364	414	358	324	279	345
SC	61.3	60.3	62.4	62.8	63.3	62.2	404	448	387	355	349	379
TN	59.0	58.9	60.7	59.6	60.7	60.0	413	476	504	418	396	434
VA	67.3	66.0	69.0	68.5	70.0	68.5	333	374	320	309	285	320
SE avg.	**60.1**	**60.6**	**62.6**	**61.3**	**61.5**	**61.3**	**430**	**466**	**414**	**377**	**340**	**400**
US avg.	**69.0**	**69.6**	**71.1**	**71.4**	**72.7**	**70.8**	**322**	**319**	**296**	**276**	**228**	**284**
% diff.	**-13**	**-13**	**-12**	**-14**	**-15**	**-13**	**+25**	**+20**	**+28**	**+27**	**+33**	**+29**

Adapted from USDA/ARS Animal Improvement Program Laboratory reports on somatic cell counts of milk from DHI herds (2001 – 2010). Information from all states can be found at http://aipl.arsusda.gov/ publish/dhi/scc.html.

In addition to lower milk production, milk quality in the SE is the poorest of all the regions in the US. Poor quality milk has a high number of somatic cells, and is an inferior product with reduced processing properties resulting in reduced shelf-life of dairy products (Boor et al., 1998; Barbano et al., 2006; Ma et al., 2000; Jayarao et al., 2004). On the other hand, high quality milk has a very low number of somatic cells, has a longer shelf-life, tastes better, and is more nutritious. One characteristic feature of cows with mastitis is a significant elevation in the number of somatic cells in milk, known as the SCC. Milk from uninfected mammary glands contains < 100,000 somatic cells/ml. A milk SCC > 200,000/ml suggests that an inflammatory response has been elicited, that a mammary quarter is infected or is recovering from an infection, and is a clear indication that milk has reduced manufacturing properties. It is not uncommon for milk from cows with mastitis to contain several hundred thousand and even millions of somatic cells/ml of milk. Thus, an increase in milk SCC is a good indicator of mastitis, which alters milk composition and reduces milk yield. Most studies that evaluated the influence of mastitis on milk composition used SCC as the basis for determining the infection status of udders and for determining the degree of inflammation.

The US average DHI SCC in 2010 as a measure of quality was 228,000/ml, but this figure for the SE was 340,000/ml (range 274,000-421,000), or approximately 50% higher than the national average (**Table 2**). From 2001-2010, the SE states, for the most part, have progressively decreased their DHIA SCC; however, each state's 10-yr average is still >100,000 cells/ml higher than the national average, demonstrating lower milk quality in this region. It should be noted that although climactic differences likely contribute to the differences in SCC, the differences in mean SCC between geographically adjacent SE states are substantial, suggesting that

implementation of mastitis control programs can have a positive impact under similar climactic conditions, and that milk quality can be improved through use of cost effective control strategies.

Lower milk production and reduced milk quality that are affecting the sustainability of the SE dairy industry are attributed to an increase in the prevalence of mastitis on farms in this region. In fact, mastitis remains a major livestock disease for all US dairy producers, with losses of approximately $2B/year (Hogan et al., 2012). To comply with global quality standards, consumer demand, and exportation requirements, the US dairy industry is striving to reduce the level of mastitis, improve product quality, and increase returns to producers. To make this a reality, the US legal limit for SCC in raw milk may soon be reduced from the current regulatory limit of 750,000/ml (FDA Grade A Pasteurized Milk Ordinance, revised in 2009) to 400,000/ml.

Dairymen in the SE will have to adopt stricter methods of mastitis control in their milking herds, dry cows, and heifers to reduce the incidence of mastitis, increase milk production, and successfully lower bulk tank SCC to be competitive with the rest of the Nation. Producers have had several historical tools at their disposal to incorporate into mastitis control programs. Yet the extent to which dairymen have adopted such control measures (or lack of adoption) is surprising. During the last 4 yr, there have been 2 surveys that monitored mastitis control practices followed by dairymen: National Animal Health Monitoring System, 2007; and Hoards Dairyman, 2010. Survey results showed only 6 in 10 US dairymen (60%) have actually adopted most of the mastitis control practices that have been stressed over the years by mastitis control experts.

The vast majority of herds with a SCC above 400,000/ml are located in the SE, and one excuse has been that the heat and humidity experienced during summer months make it impossible to lower SCC in this region. Heat and humidity do not cause mastitis, yet these factors increase the ability of mastitis-causing bacteria to grow and thrive in the cows' environment. However, it is the management deficiencies on many SE farms that allow these potential pathogens to actually cause infections. There are many well managed operations in the SE that consistently have SCC well under 400,000/ml throughout the year; thus, maintaining this level can be achieved. Traditional mastitis control measures as well as newer management strategies have been proven to work, and have been adopted by those southern dairymen producing high quality/low SCC milk; those struggling with milk quality need to emulate their successful neighbors.

One approach for improving the sustainability of the SE dairy industry is the development of a collaborative educational, research, and outreach program on mastitis control assembled by milk quality professionals that targets challenged dairy farms and uses those farms producing superior quality milk as demonstration herds. The program's research-based information will be packaged for educational and outreach delivery to stakeholders including dairy producers, veterinary practitioners, university students, extension personnel, and agri-industries associated with the dairy industry. Implementation of cost effective mastitis prevention and control strategies for the SE region will result in higher milk quality, increased production, and improved profitability, all of which will enhance the sustainability of the dairy industry in this region.

***RATIONALE and SIGNIFICANCE*:** The dairy industry in the SE is in serious jeopardy. A significant decline in the number of dairy farms coupled with lower milk yields per cow and production of lower quality milk poses significant problems for the vitality of dairy farms in the

SE and sustainability of the SE dairy industry. From 1995 to 2010, the number of dairies in the SE has declined significantly, with a 64% reduction in licensed dairy farms; AL, AR, KY, LA, MS, and TN recorded declines ranging from 66 to 81% over this 16-yr period (**Table 1,** (Herndon, 2011). Consequently, the SE realized a 37% *decline* in total milk production from 1995-2010, while the US experienced a 24% *increase*. In addition, milk production per cow in the SE lags the rest of the US by about 13%. Milk quality is consistently the poorest of all the regions of the US (**Table 2**); the SE 2010 DHIA SCC averaged 50% higher than the national average. The outlook is not good…..and using 16-yr trend data, the expected number of dairy farms in the SE will decline by 56.7% between 2010 and 2025 to only 2,170 operations (Herndon, 2011). If this happens, milk production is forecasted to decline by 35% in the SE between 2010 and 2025, whereas US production will increase by 23% (Herndon, 2011).

We believe that if the SE dairy industry is to survive, it is of paramount importance to develop initiatives that include outreach, educational, and research components to improve milk quality and milk production. Our goal is to enable dairy farmers to move profitably toward production systems compatible with the concept of a sustainable dairy industry in the SE.

Objectives of this proposal relate directly to Program Area Priorities identified by USDA AFRI:

- Reduce the economic, environmental, and social consequences of animal and plant pests and diseases with major impacts on food availability.
- Decrease the use of antibiotics and pesticides in agriculture and food production and associated health and environmental risks.
- Increase animal and plant products produced with the same or fewer resources.
- Increase the number of farms engaged in local and regional food systems that use sustainable practices.
- Increase food security, especially in vulnerable communities.
- Increase and strengthen local, regional, national, and international markets.
- Strengthen the sustainability and economic resilience of rural communities.
- Develop a cadre of well-trained, diverse groups of scientists, educators, extension specialists, and producers with skills to address sustainable global agricultural production and foster international partnerships.

Our approach for improving the sustainability of the SE dairy industry is the development of a multi-state collaborative outreach, educational, and research program on production of quality milk assembled by milk quality professionals from 6 Land-Grant Universities (KY and MS are eligible for USDA EPSCoR funding) in the SE that targets challenged dairy farms and uses farms producing superior quality milk as demonstration herds. We will identify economic, social and psychological factors affecting limited adoption of practices known to control mastitis, and develop strategies to counter the rationale for non-adoption. This knowledge will lead to more effective strategies to overcome these issues and facilitate adoption of practices for enhancing milk quality. We will conduct applied research and on-farm demonstrations including implementation strategies for controlling mastitis and enhancing milk quality (National Mastitis Council, 2006) and work directly with producers to assess on-farm practices. The program's applied research-based and demonstration farm information will be packaged for educational and outreach delivery to stakeholders including dairy producers, veterinary practitioners, university students, extension personnel, and other agri-industries serving the dairy community. By using

print, face-to-face, and electronic delivery vehicles (including DAIReXNET webinars and Spanish translations), we will train dairy producers and employees to utilize current and newly developed tools to make on-farm decisions that improve milk quality. We also plan to develop continuing education programs to create human resources needed to serve the dairy industry by targeting practicing veterinarians and personnel serving the industry for providing more immediate help, and undergraduate/graduate students to provide long-term solutions. Continuing education courses taught using traditional venues and provided through DAIReXNET webinars and directed internships will provide real world experiences on milk quality, and result in a more knowledgeable work force to promote the sustainability of the SE dairy industry.

We envision that the impact from this study will be enormous. Potential outcomes include: 1) dairy producers in the SE with an improved understanding of the economic impact of mastitis, leading to increased motivation to change management practices and improve animal health and well-being; 2) implementation of cost effective science-based mastitis prevention and control strategies resulting in higher quality milk, increased production, and improved profitability to enhance sustainability; 3) meeting human food and fiber needs while enhancing environmental quality and the natural resource base upon which the agriculture economy depends; 4) making the most efficient use of nonrenewable and on-farm resources and integrate natural biological cycles and controls; 5) sustaining the economic viability of SE dairy farm operations; and finally, 6) enhancing the quality of life for farmers and society as a whole. ***We have significant support from State Departments of Agriculture, Farm Bureau, state dairy and veterinary associations, agri-industries serving the dairy industry, milk cooperatives, and the National Mastitis Council*** (please refer to letters in the ***Documentation of Collaboration*** attachment).

***OBJECTIVES and APPROACH*: W**e have outlined 4 key objectives:

Objective 1) Identify economic, social and psychological factors affecting limited adoption of practices known to control mastitis and develop strategies to counter the rationale for non-adoption (**Leader – Fly; Participants - Garkovich, Krawczel).** Societal, financial, family, and farm infrastructure factors will be identified using extension-driven approaches. This knowledge will lead to more effective strategies to overcome these issues and facilitate adoption of practices that enhance milk quality.

If the decision to adopt the most effective method of mastitis management were purely an economic one, then this condition would not be a "problem" for the industry. This suggests that other, noneconomic factors (e.g., individual values, farm and family goals, household composition, economic issues) as well as structural characteristics of the operation enter into this decision process. A dairy farmer is a manager, laborer, and family member, and each role has different rights and responsibilities as well as values, preferences, and goals. A further complication is the complexity in enterprise types, from small family owned and operated to large enterprises with layers of management and labor. Thus, an assessment of the biological/clinical, economic, sociological, and psychological factors involved in management decisions at all levels is needed. This objective will be completed in 4 phases:

1. Gather and evaluate existing data on SCC in the SE region and map (using GIS) to determine if there are geographic patterns in SCC.

2. Conduct a qualitative, comprehensive assessment of factors influencing the adoption of practices known to control mastitis and related dairy sustainability issues.
3. Conduct a survey of producers in the SE who have gone out of business in the last 5 yr.
4. Conduct a survey of existing dairy producers in the SE region.

There is considerable variation within the SE as to number of herds/cows, milk production, and SCC (**Tables 1** & **2**), and the first phase of this objective will enable us to determine if there are geographic characteristics associated with low or high SCC. The geographic patterns may provide insight into both economic (e.g., where producers market their milk) and noneconomic (e.g. climate) factors that might contribute to the patterns.

To fully explore the role of mastitis management in the sustainability of SE dairy farms, we will conduct 2 surveys. Questions will be based on extensive qualitative exploration through 45 personal interviews and 4 focus groups of dairy owners/managers about mastitis management and other farm sustainability issues. Interviews will be guided by a protocol requiring specific topics to be addressed and allowing flexibility for all relevant factors to be identified and explored. Using this input, research specialists will develop an instrument to quantitatively assess the frequency and importance of the factors that affect adoption and successful implementation of mastitis management practices related to dairy sustainability. The survey will be administered to 2,490 farms in 6 states across the SE representing low, medium, and high sustainability herds based on the number of dairy farms and cows lost in the last 15 yr. We will draw a sample large enough for in-state stratification in 3 states (KY, TN, VA) given the larger number of dairy farms in those states. For the other states (MS, GA, FL), we will use the total population of farms because the number of dairies in those states is small. Combined, the sample size will be 2,490. The lower-bound anticipated number of completed surveys is 872 with a response rate of 35%. To enhance the robustness of the dataset for sub-strata analyses, we will provide an incentive (prize-type) to increase the response rate to approximately 42%, which would result in 1,042 completed surveys. For out-of-business farms, we will do a census of all farms that have ceased operation in the last 5 yr to provide a sample size of 929 former dairy farms and 300 completed surveys. Testing for non-response bias will be performed through telephone surveying of non-responders using key questions.

The survey will include questions encompassing both economic and non-economic factors, such as individual and farm goals and sources of information that may influence decision-making and implementation. Respondents will be asked to explain how they would make decisions about different scenarios (e.g., relating to mastitis management and innovations for improving milk quality). Engaging operators of different sized dairies and with a range of operating structures will help identify the diversity of factors that contribute to the complexity of management decisions.

GIS data, focus groups, personal interviews, and mail surveys will contribute to a more complete understanding of the non-economic factors that influence mastitis management decisions. Our sample will have 3 populations: 1) those expecting to remain in business for 5-10 yr or more; 2) those who expect to go out of business in the next 5 yr; and 3) those that have gone out of business. Upon completion, dairy professionals will have an increased comprehension of all factors (economic, social, and psychological) that impact producer decisions related to mastitis

management. We will be able to determine what role mastitis plays relative to other factors that affect sustainability of dairy herds by surveying farms in and out of business. This robust dataset will allow predictive modeling and market segmentation to facilitate program development.

Milestones – Deliverables	Year	Expected output and/or outcome
GIS Report	1	Provide predictors for prevalence of mastitis and related social variables.
Focus Groups, Personal Interviews Report		Qualitative identification of set of factors that influence decisions about mastitis management with assessment of their context, importance, and interdependence; results will guide survey development.
Dairy Farmer Preliminary Survey Report	1	Quantitative identification of significant factors that influence decisions about mastitis management.
Former Dairy Farmer Preliminary Survey Report		Identify management practices and non-management related characteristics of dairies most at risk and provide guidance to development of outreach programs.
Final Survey Report	2	Provide guidance to development of outreach programs.
State-level Report		State-level assessment for three states to identify within state conditions to inform the roll-out of the outreach programs.
Personal Interviews Report	5	Qualitative exploration of reach and effectiveness of outreach programs and recommended improvements; results will guide follow-up survey development.
Final Survey Report	5	Quantitative evaluation of the effectiveness of outreach programs and recommended improvements.

Objective 2) Conduct applied research and on-farm demonstrations to evaluate management practices, including implementation strategies, required to control mastitis and enhance milk quality (Leader – Pighetti; Participants - Almeida, Petersson-Wolfe, Hill-Ward, Bewley, Oliver, Krawczel). We will work directly with producers to assess on-farm practices that enhance milk quality. Extension programs and educational resources relevant to SE dairy producers will be developed and published for improving milk quality using input obtained from on-site personnel and results from management practices analyses.

2.1. Evaluate the current status of milk quality in the SE. To develop effective milk quality programs that target issues observed in the SE and assess their subsequent effectiveness, it is necessary to obtain an initial picture of milk quality that is assessed annually thereafter. To accomplish this, we will utilize 2 separate but complementary approaches: 1) Examine milk quality of the herd as a whole by evaluating SCC and standard plate count (SPC) records

collected for Grade A milk. The benefits of this approach are that microbiological measures are available in addition to SCC, inclusion in the survey does not rely on participation in a DHI program, and samples are collected throughout the year. 2) Use DHI records to examine milk quality by evaluating SCC records of individual cows and how they contribute to whole herd (i.e., bulk tank) SCC. The initial analysis will be conducted on data collected during the 2011 calendar year to provide a baseline and annually thereafter to provide an objective measure of the success of the SEQM program.

2.1.1. Milk quality data collection - bulk tank. To accomplish this, we will work in conjunction with Dairy Farmers of America and Maryland Virginia Milk Co-Operative (refer to letters in ***Documentation of Collaboration***) who routinely conduct milk quality analyses on bulk tank milk from dairies in the SE. This will allow an assessment of many farms throughout an entire year, as opposed to a subset of farms sampled a limited number of times, and provide a more comprehensive assessment of milk quality in the SE. Data obtained from milk cooperatives and processors will include herd identification number, date, state/county, pounds of milk shipped, SCC and SPC. When additional microbiology tests such as preliminary incubation counts are available, these also will be included. All data will be integrated into a database, allowing assessment of milk quality by region, seasonal variation, production levels, and milk buyer.

2.1.2. Milk quality data collection - DHI. Although bulk tank assessment provides a comprehensive picture of milk quality at the herd level, it does not provide detail regarding how individual cows contribute to the bulk tank, nor how these dynamics change with season or region of the SE. With 30-40% of SE herds utilizing DHI, we estimate that approximately 800 herds will have DHI records including test day SCC and milk yield for individual cows across a lactation, as well as herd characteristics such as rolling herd average, SCC, herd identification number, and state/county.

2.1.3. Statistical analyses. Statistical analyses will be conducted to evaluate the severity of the milk quality problem, the influence of season on milk quality measures, and the influence of geographic region on milk quality. A mixed model ANOVA will be used (SAS, 1985) to analyze bulk tank and DHI records. The base model will evaluate fixed effects of season and geographic region, and the random effect of herd for bulk tank data or cow for DHI data. When both bulk tank and DHI records are available, the correlation between bulk tank SCC and DHI weighted SCC will be determined.

2.1.4. Outcomes. Upon completion of the initial report, we will have an accurate assessment of the current state of milk quality in the SE. This information will be used to: 1) provide annual reports to producers and affiliated industries on the current status of milk quality; 2) focus on future research and educational materials relative to season, geographic area, and severity of problem; 3) stratify herds into low, average, and high milk quality herds; and 4) provide a means of assessing effectiveness of educational programs.

2.2. Evaluate milk quality practices on farms producing low, average, and high quality milk. Milk quality practices employed by those herds producing low, average, and high quality milk as determined by SCC will inherently differ in nature. Identifying those practices that are unique within each quality category will provide insight to developing education and outreach

activities to help producers enhance milk quality. Practices employed by dairies producing high quality milk will provide a roadmap to help dairies producing lower quality milk, as well as indicate additional knowledge needed by dairies to maintain production of high quality milk.

2.2.1. Identification of herds for participation. A total of 306 herds will be evaluated in KY (n=96), MS (n=18), TN (n=96), and VA (n=96). Within each state, the 2011 commercial bulk tank SCC will be used to stratify herds into low (bottom 33%), average (middle 33%), and high (top 33%) quality milk herds. Through milk buyers (e.g. dairy cooperatives and processors), herds will be contacted and requested to participate. Within each state, herds will be balanced equally among low, average, and high quality SCC herds.

2.2.2. Assessment of on-farm practices. This analysis will include a survey of practices related to milking time, milking equipment, antimicrobial treatments, manure removal, and stall maintenance, as well as evaluation of cow/farm cleanliness, body condition score, lying/standing behavior, and stocking densities. To account for season, assessments will be conducted monthly on an equal number of farms from each quality group. Assessments will be completed by personnel from KY, MS, TN, and VA trained during a group training session in year 1 led by TN. This will enable uniform definitions and scoring to help standardize assessment of dairies and data collection.

2.2.3. Assessment of milk quality. To identify mastitis pathogens problematic for low, average, and high SCC herds, an expanded panel of microbiological tests will be conducted on bulk tank milk by Quality Milk laboratories in TN and VA (Gillespie et al., 2008; Jayarao et al., 2004; Murphy and Boor, 2000; Oliver et al., 2004). This will include SCC, SPC, preliminary incubation count (PIC), laboratory pasteurization count (LPC), and counts for staphylococci, streptococci, coliforms, Mycoplasma, and Prototheca (*Standard Methods for the Examination of Dairy Products*, 2004).

2.2.4. Statistical analysis. Analyses will be conducted to identify those practices that promote or compromise production of high quality milk. Descriptive statistics of herds will be calculated using Proc Means and Proc Freq (SAS, 1985). The influence of management practices on bulk tank SCC and SPC will be assessed using a mixed model ANOVA (SAS, 1985). The base model will include fixed effects of season (as defined in **Objective 2.1.2**), milk yield, number of cows, and explanatory variables of interest and random effect of herd. Each herd characteristic will be tested and backwards regression used to identify those variables that best explain or contribute to elevated bulk tank SCC.

2.2.5. Outcomes. Upon completion of **Objective 2.2**, we expect to have identified those practices that promote or limit milk quality. Additionally, a survey of antimicrobial use on the farm will provide greater insight to typical practices in the SE. With this knowledge, we will: 1) generate a report that will be made available to producers; 2) develop educational and outreach opportunities tailored for each milk quality classification; and 3) develop recommendations and educational materials for the judicious use of antimicrobials.

2.3. Demonstrate and assess producers adopting practices that promote milk quality. Farms with low to average quality milk will be enrolled in an on-farm assessment and modification

program that will involve 4 phases: 1) pre-trial evaluation of dairy farm management practices; 2) development of an objective mastitis control and milk quality plan; 3) implementation of the mastitis control and milk quality plan; and 4) evaluation of the mastitis control and milk quality plan. Upon completion, results will be analyzed and science-based educational and outreach materials developed and disseminated.

2.3.1. Identification of herds for participation. Thirty herds will be evaluated annually in KY, MS, TN, and VA during years 3 to 5. Each year, 3 herds each from KY, TN, and VA and one herd from MS will be enrolled in the on-farm assessment and modification program. Potential herds with low to average SCC (bottom 66%) will be identified through the commercial bulk tank report compiled from the prior year and/or herds that have requested aid through the extension or research arms of the universities.

2.3.2. Pre-trial evaluation of dairy farm management practices, mastitis incidence and milk quality. Questionnaires will score management practices related to milking time hygiene, milking equipment, antimicrobial treatments, manure removal, stall maintenance, evaluation of cow/farm cleanliness, body condition score, cows lying/standing behavior, and stocking densities. This assessment will be based on the survey delivered in **Objective 2.2**, but updated to reflect observations made on farms and/or newly published literature. Mastitis assessment will include an evaluation of historical herd and individual cow SCC data and bacteriological analysis of quarters with high SCC. Assessments will be completed by personnel from KY, MS, TN, and VA trained during a group training session in year 1 led by TN. This will enable uniform definitions and scoring to help standardize data collection. Data obtained from the analysis of herd records in addition to the information on herd management and milk quality will be used to define benchmarks and set goals for each farm.

2.3.3. Develop a farm-specific mastitis control and milk quality program. After initial assessment, a mastitis control and milk quality program that includes specific and realistic goals tailored for that farm will be proposed. At a minimum, this program will include proven procedures recommended by the National Mastitis Council (NMC, 2006) known to be effective at controlling mastitis including proper milking time hygiene, milking machine function, pre- and post-milking teat disinfection, lactation therapy, antibiotic dry cow therapy, and culling of chronically infected cows.

2.3.4. Assessment of mastitis control and quality milk plan implementation. To assess implementation of the recommended plan, farm visits will be made monthly for the first 6 mo and every 2 mo for the next 6 mo. A final visit will be made at 24 mo after completion of the program to determine if practices are maintained over time. At each visit, the survey questionnaire and assessment will be conducted as outlined in **Objective 2.3.2.** After 1 and 2 yr of application, accomplishment of the prescribed benchmarks and goals will be determined. Success will be evaluated by enhanced milk quality as measured by a reduction in bulk tank SCC, increased milk yield, decreased antimicrobial use, decreased clinical mastitis incidence, and reduced culling due to mastitis and/or low production.

2.3.5. Statistical analyses. Descriptive statistics of herds enrolled will be calculated using Proc Means and Proc Freq (SAS, 1985) as described in **Objective *2.2.4***.

2.3.6. Outcomes. Upon completion of **Objective 2.3**, we expect to have identified those practices that lead to chronic milk quality problems and how to best handle these problems in cooperation with the producer. With this knowledge, we will: 1) develop educational and outreach opportunities tailored to helping farms with certain types of problems, and 2) enhance producer confidence that these programs are effective in the SE.

Objective 3) Provide producers with decision-support tools and services needed to make informed decisions regarding milk quality (Co-Leaders - Bewley and Petersson-Wolfe; Participants – Amaral-Phillips, Arnold, Krawczel, Nickerson, De Vries, Oliver, Almeida). We propose to provide dairy producers with decision support tools, on-farm analytics, and educational support materials needed to make more informed decisions related to milk quality. Through a combination of print, face-to-face, and electronic delivery vehicles including DAIReXNET webinars and Spanish translations, we will train dairy producers, employees, and industry professionals to use current and newly developed tools to make on-farm decisions to improve milk quality, emphasize prudent use of antibiotics, and ensure long-term farm profitability and sustainability. Specifically, we aim to: 1) develop a suite of multifaceted and user-friendly decision support tools related to animal health economics; 2) integrate developed tools into existing dairy management software and/or hand-held devices; and 3) develop educational programs to train and provide support to producers and farm advisory professionals.

The suite of producer-focused tools and materials will include 1) consideration of economic factors associated with mastitis; 2) standard operating procedures (SOPs) and videos related to milk quality management and mastitis prevention practices; 3) understanding milk cultures and an online mastitis pathogen reporting system, and 4) on-farm assessment programs to investigate risk factors for mastitis. These tools will be available via the Internet on the SQMI website and a YouTube video channel, through Smartphone applications, printed and bound copies, and on USB storage devices. The SQMI website will be newly developed and designed to house all information generated from the project. Available information will include survey results from **Objective 1**, farm reports and culture results from **Objective 2**, tools, on-farm analytics, and support materials of **Objective 3,** and components of the continuing education programs developed in **Objective 4**. Where appropriate, the site will be interactive, allowing producers to tailor a milk quality program to fit their operation. The site will house video clips, 1-page fact sheets, SOPs and economic dashboards. A portion of the SQMI website will be open to the public, with other areas under password protection where producer information will be stored.

3.1 Decision support tools and analytics: While numerous quality economic estimates and decision tools have been developed over the last 20 yr, advances in computing power, decision sciences, and end-user interfaces have opened the door for a new era in dairy farm decision support. In this multi-university effort, new estimates of the economic impact of mastitis will be developed, and new, robust, user-friendly tools will be offered to improve producer decision-making, leading to increased motivation to alter mastitis management practices and improve milk quality. These changes will also have a positive impact on animal well-being, reduced antibiotic usage, and improved dairy operation sustainability and profitability in the SE.

A farm-level decision-support tool will be developed to better quantify the economic impact of

mastitis, which will be based on an existing model developed at the University of Kentucky. Bewley et al. (2010) developed a farm-specific stochastic simulation model for producers, their advisers, and technology manufacturers. This model will be expanded with specific emphasis on refining mastitis costs to assist dairy producers with farm-level decisions related to mastitis management. Farm-specific estimates of losses due to mastitis will be calculated with this tool. Price and biological risk will be considered through stochastic simulation, and cost of culling will be calculated using the retention pay-off concept. New and more accurate estimates for costs of drugs, labor, and veterinary services will be obtained. The model will be expanded to include impacts on farm profitability through DuPont analysis. This effort will provide the first estimates of mastitis at the business level by measuring changes on Return on Assets and provide an analysis tool for measuring the impact of SQMI on farm profitability. The comprehensive stochastic simulation model will be used to develop partial budgets for mastitis prevention, detection, and control solutions or products.

In addition to the more detailed simulation model, a series of simple partial-budget dashboards will be created to target decision-making for pathogen-specific mastitis culture, treatment, and culling decisions with specific emphasis placed on reduced antibiotic use. Similarly, partial-budget dashboards will be created to assist dairy producers to understand the economic implications of mastitis prevention strategies including mastitis vaccines, bedding management, and dry cow treatment strategies. These dashboards will allow for input of farm-specific data to determine whether the observations made on-farm are cause for concern. This suite of udder health management tools will be incorporated into dairy herd management software and also, where applicable, as downloadable applications to Smartphones. Investigators will work closely with Dairy Records Management Systems (Raleigh, NC) to incorporate decision support tools and key performance indicators into existing software. By working with an existing organization, we will build upon the value already provided through the DHI program by taking advantage of existing infrastructure and minimizing farmer data entry. These efforts will bring SCC analytics to a new level improving farm-level and individual cow decisions, and provide producers with a more integrated and user-friendly approach to making milk quality decisions.

3.2 Educational support materials: A comprehensive set of SOPs and informational fact sheets in printed and/or video format, will be developed, along with mastitis management key performance indicators (KPIs) and decision flowcharts. These educational materials will be available to the public through the SQMI website. The SOPs will include milking preparation, collection of milk samples using aseptic technique, on-farm milk culturing, teat end and, hygiene scoring, antibiotic treatment methods, vaccination use, milking equipment maintenance, bedding considerations, animal environment and cleanliness, compost barn management, dry and transition cow management, heat abatement, dairy records management, genetic selection for improved mastitis resistance, pasture cleanliness, and freestall modernization strategies. One-page metric sheets based on DHIA records will be created to facilitate development and tracking of farm-specific KPIs. Creation of flowcharts to aid in mastitis treatment and decision-making will target reduced antimicrobial use and improved milk quality. Documents most commonly used by hired labor will be translated into Spanish and made available via the internet, in printed form with explanations, and also as 1-page documents suitable for lamination to be posted on-farm and in milking parlors.

Milk culturing is an important aspect of both improving and maintaining milk quality and will be provided by Milk Quality Laboratories (TN, VA). Regular milk culturing will help producers reduce antibiotic use and choose the appropriate antibiotic for cases that require treatment. However, interpretation of milk culture results is a difficult task for producers and industry professionals, so an online milk culture reporting system will be developed as part of the SQMI website. This will serve as a database of culture results for the project, and will provide a customized report to producers including explanations with pertinent information regarding control, spread and treatment options with emphasis on the need for a veterinary-client-patient relationship. The report will also hyperlink to a more expanded explanation of each bacterial pathogen and decision support economic dashboards; printed versions will be provided by request. Milk Quality Laboratories at TN and VA will utilize this system for the scope of the current project, and other university, veterinary diagnostic, and industry laboratories will have the opportunity to adopt this reporting system.

A series of user-friendly, on-farm evaluation tools and dashboards can assist farm personnel and industry professionals in determining potential areas of concern related to milk quality. Evaluation tools would include those related to milking preparation procedures, evaluation of milking equipment function, teat end, and teat skin and cow hygiene scoring. A milk quality troubleshooting evaluation tool will be developed for dairy advisors to use from a tablet computer or Smartphone, enabling advisors to personalize trouble-shooting efforts while entering farm information at the milking parlor and dairy facilities. End-users may be dairy producers or industry professionals, many whom have Smartphones. Therefore, we believe it is important to provide these materials as both printed documents and as Smartphone applications.

Training workshops will be developed and executed across the SE to educate individuals on the use of these tools. Targeted workshops for both producers and industry professionals would provide the knowledge and support for proper use and interpretation of results. At these workshops, the tools will be demonstrated along with interpretation guidance. Segments of training sessions will be video recorded (in 5-min segments) and made available via the internet and on USB storage devices for producers with difficulty accessing the internet.

Through the development of these tools, we acknowledge the need for a support team to serve as advisors on the use of these products, and will hold discussion groups and quarterly question and answer conference calls between the SQMI coordinators and interested dairy producers and industry professionals. Furthermore, we plan to provide training sessions for farm management teams to aid in on-farm consultations and troubleshooting, and will establish a regional electronic listserv for the dissemination of newsletters and information about mastitis management. To recognize those producers with exceptional milk quality, we will establish an awards recognition program for herds with superior quality and those who have achieved SCC reductions.

With this suite of robust, flexible decision-making tools and educational materials, producers will be able to make more informed decisions at all levels. Dairy professionals will have an increased comprehension of economic and social factors that influence dairy producer decisions related to mastitis management. Dairy producers will have an improved understanding of the economic impact of mastitis, leading to increased motivation to change mastitis management, thereby improving animal health and well-being and farm sustainability. In addition, we will partner with the NMC to disseminate this information nationally and internationally.

Milestone – Deliverables	Year	Expected output and/or outcome
SQMI website	1	Provides dairy producers and industry stakeholders a portal for information developed and discovered in the SQMI project.
Customized reporting for milk culture results	1	Information about mastitis-causing pathogens provides producers with knowledge regarding control, prevention, and spread of bacteria.
Key performance indicators	2	Simple metrics provide dairy producers with monitoring tools needed for SCC reduction.
Suite of tools related to milk quality	2, 3, 4	Improved farm profitability as measured through Return on Assets with DuPont Analysis.
Economic simulation model	4	Improved farm profitability as measured through Return on Assets with DuPont Analysis.
Partial-budgets	4	Improved farm profitability as measured through Return on Assets with DuPont Analysis.
Downloadable Smartphone applications	5	Increased adoption of educational materials from dairy extension and industry professionals.
Incorporation into herd management software	5	Seamless transfer of information between existing and new systems.
Question and answer sessions	2, 3, 4, 5	Increased understanding of use of developed tools, dashboards, KPIs, and partial-budgets.

Objective 4) Develop continuing education programs to create human resources needed to serve the dairy industry (Leader - Nickerson; Participants - Bewley, Petersson-Wolfe, Amaral-Phillips, Arnold, Hill-Ward, De Vries, Oliver, Pighetti). The sustainability of the SE dairy industry will depend, in part, on the continual availability of milk quality professionals educated to extend their expertise to stakeholders. Such professionals include veterinarians, allied industry support personnel, and extension educators. This group needs continuing education regarding new advances and reinforcement of key concepts in mastitis control and milk quality. Educational materials and decision support tools for use with local clientele will help in the dissemination, implementation and improvement of on-farm milk quality. At the same time, educational resources and learning opportunities for the next generation of milk quality professionals must occur. To provide these educational sessions and materials, a combination of one-on-one training sessions, printed material, and web-based resources will be used, including Spanish resources.

4.1. Training allied industry personnel, veterinarians and local extension educators. Distributing useable information to veterinarians and other allied dairy industry personnel will be a key component for addressing milk quality issues. Regional conferences at 3 locations in the SE in years 3 and 5 will be held to: 1) update stakeholders on success stories of how to maintain and improve milk quality in the SE; 2) discuss social factors that must be considered when changing management practices; 3) provide updates on key concepts and advances in milk quality; and 4) offer overviews (via trade shows) of new materials available for educator use with producers and their own self-study. Success stories will be in the form of 5-10 min “You Tube” videos illustrating on-farm changes with top producers explaining what they changed and the impact they experienced in their operations. Quarterly, 2-page electronic newsletters will be

published to follow up on the concepts and materials presented at these conferences, and all resources available at these conferences will be posted. In addition, we will partner with the National Mastitis Council to disseminate this information nationally and internationally.

Dairy veterinarians are trusted by producers, are considered credible and reliable sources of information, and are familiar with the day-to-day routine procedures on the farm. The challenges of reaching veterinarians include the lack of high speed internet access in rural areas, lack of time that practicing veterinarians have to dedicate for training modules, and lack of continuing education courses that address methods to improve milk quality. Furthermore, the overall poor quality of milk from the SE contributes to a pervasive attitude that a low SCC cannot be achieved in a hot, humid climate.

In order to reach practicing veterinarians, extension personnel will develop a working database of food animal veterinarians. Research-based training modules will be developed for continuing education credits for veterinarians (password protected). These topics will be similar to those developed for graduate courses listed below with an additional module on specific drug use in the treatment of mastitis for practicing, licensed veterinarians. Modules will be accessible to veterinarians online and used by state extension veterinarians and university faculty for on-site, state-wide educational sessions. Timely newsletters including resources available to use with their clientele and regulatory changes in medications and residue testing will be developed and distributed electronically, or if requested, faxed or printed and mailed. Equipping veterinarians with the resources needed to teach best management practices to clientele is an integral component of controlling mastitis and improving milk quality. In addition to resources developed for producers, undergraduate/graduate/veterinary students, further teaching materials (i.e., PowerPoint presentations) will be developed and/or reviewed and indexed on-line for veterinarians to use at locally-sponsored producer meetings. Additional areas for educational materials will include: Aseptic collection of milk samples for bacterial culture and how results are used to devise an on-farm action plan; prevention of antibiotic residues in milk and meat; judicious use of antibiotics to decrease antibiotic resistance; explanation of extra-label drug use and implications for milk and meat withholding times; importance of record keeping and official identification of all cows on the dairy; and dangers of raw milk consumption.

4.2. Training the next generation of milk quality professionals. To ensure the availability of a new generation of trained personnel and provide long-term solutions, undergraduate, web-based courses specifically designed to cover topics in milk quality and mastitis control and/or modules in these areas to be incorporated into existing dairy-related courses will be developed, tested, and revised based on student comments at participating SE land-grant universities. Exposure to such course material will not only educate students in this area, but also pique their interest in the many issues related to udder health and mastitis, and help to direct careers toward this area whether students are enrolled in animal and dairy science BS programs, pre-veterinary curricula, biology, or agricultural education programs. In addition, these materials will be available for students involved in SE Dairy Challenge to learn more about evaluating mastitis control practices on-farm and made available for producers and their employees for self-learning.

The undergraduate module courses specifically designed to cover topics in milk quality and mastitis control in these areas to be incorporated into existing dairy-related courses will cover

topics in the following areas: Mastitis prevalence, public health significance and economic losses to producers; effects of mastitis on yield, composition and milk quality (SCC); the microorganisms that cause udder disease (contagious, environmental); development of mastitis and the cow's response to intramammary infection; detection and diagnosis of mastitis at the cow and herd levels; control methods for preventing the establishment of mastitis; over the counter (OTC) antibiotic therapy to treat existing cases of mastitis; establishing a Veterinary-Client-Patient Relationship and use of prescription antibiotics; influence of the milking machine on udder health; and lactation, including the basics of mammary anatomy and physiology.

In addition to formal classroom media, internships will be available to undergraduate students. Several Animal and Dairy Science Department curricula require such internships as part of the undergraduate program. Each internship will require a minimum of 120 hr for up to 6 hr of credit, which may last an entire semester. Internships are supervised by faculty members, and can be carried out at university or cooperator dairy farms, commercial laboratories, or veterinary practices. Students are provided with a project at one of these sites that includes observations, data collection and analysis, a written internship report, and an evaluation of the student intern by their supervisor. The experience should serve to enhance the student's understanding of the application of the scientific principles provided in their previous coursework to the management techniques followed at the internship site. Examples of internship projects include: Efficacy evaluation of intramammary infusion products per label to treat mastitis; prevalence of mastitis in dairy herds and development of control practices; troubleshooting herds with elevated bulk tank somatic cell counts; evaluation of immunostimulant feed supplements in preventing mastitis; efficacy evaluation of mastitis vaccines in dairy heifers; and role of fly control in preventing the initiation and spread of mastitis.

In addition to undergraduate student offerings, more in-depth courses or modules will be developed for graduate and veterinary students. This will ensure that professionals with advanced degrees (MS, PhD, DVM) continue to graduate and enter the workforce that have acquired more comprehensive expertise in the mastitis and milk quality areas. These individuals may become the next generation of professionals who will continue to contribute to the betterment and sustainability of the SE dairy industry through education, extension, and research. In addition, these courses offer continuing education (and CEUs) for graduates of these programs. In-depth courses or modules to be developed for graduate and veterinary students would include: pharmacokinetics of antibiotics and other drugs use to control mastitis; mammary gland immunology and vaccinology; nutraceuticals and their application to udder health; and epidemiology of mastitis-causing microorganisms.

Implementation of science-based mastitis prevention and control strategies will result in higher milk quality, increased milk production, improved profitability, and enhanced sustainability of the SE dairy industry. Dairy veterinarians who are already involved in the diagnosis and treatment of mastitis on the farm can be one of the best providers of this scientific information. Extension programs along with resources provided by educators and researchers are among the best means to equip veterinarians for this important task, and can provide the management tools necessary to improve milk quality.

Three webinars will be conducted through DAIReXNET, specifics to include: 1) An audience of extension educators/specialists, veterinarians, allied industry partners nationally as continuing education, and for the public (i.e., dairy producers. 2) All webinars will be archived on the eXtension.org website. 3) Teaching materials in PowerPoint format from these webinars will be loaded to the web for future download. 4) Evaluations measuring the short-term impact of these materials will be accessed by those attending the live sessions of the webinars. 5) Webinars will be advertised to the appropriate audiences through electronic forms of communication, including social media. Webinars will be scheduled within the DAIReXNET educational webinar series, and scheduling will be contingent on slots available. The DAIReXNET Webinar Committee must approve speakers and content for webinar sessions, and topics are expected to be of a practical nature. Webinar listings and recordings will be hosted by DAIReXNET, and the grant recipients must link to the DAIReXNET pages with eXtension.org URLs.

Also included through DAIReXNET are: 1) Extension Audience Research Summaries consisting of 2 to 3 short paragraphs (<500 words) summarizing the conclusions of research trials will be published if accepted through peer-review; and 2) an Ask-an-Expert option: The PIs and Co-PIs will answer questions submitted through eXtension and will serve as peer-reviewers for the vetting of the answers into eXtension's Frequently Asked Questions. PIs and Co-PIs will place an eXtension Ask-an-Expert widget on their home institution websites.

Milestone – Deliverables	Year	Expected output and/or outcome
Regional conferences for allied dairy industry reps.	3, 5	Provide training for agents and veterinarians.
You-Tube videos	2, 3	Information on successful operations to motivate struggling producers.
Newsletters (quarterly)	3, 4, 5	Update support personnel with latest information
Develop training modules for veterinarians	1, 2	Provide tools and methodologies for practitioners to assist producers.
Delivery of programs through modules	3, 4, 5	Provide tools and methodologies for practitioners to assist producers.
Newsletter- vets	2, 3, 4, 5	Update support personnel with latest information.
Teaching materials for vets to use in local programs	2, 3, 4, 5	Provide training for agents and producers.
Undergraduate modules developed, classroom tested, and distributed	1,2,3,4,5	Educate students in areas of mastitis and milk quality.
Undergraduate internships	2, 3, 4, 5	Train students in areas of mastitis/quality.
Graduate courses/modules	3, 4, 5	Educate/train future mastitis researchers.

Potential Pitfalls & Limitations: **Objective 1** - Producers may not readily respond to mail surveys resulting in a lower response rate and data validity. By using the standard Dillman 4-wave method (survey, reminder, survey, reminder), providing incentives, and publicizing the survey through Extension and the industry, we expect a response rate > 30%. Data will be further validated through non-response follow-up and analysis. This should be sufficient to draw conclusions for the overall region and states with a large number of dairy herds. We may conclude that the identified non-economic issues may not have clear solutions or solutions that

are applicable to the region. If either of these conditions occurs, this would serve as the basis for testable hypotheses on the appropriate corrective course. **Objective 2** - New USDA-mandated SCC limits may result in fewer farms producing low quality milk than anticipated. However, the SE has the largest percentage of dairies with poor quality milk, so finding enough farms should not be a problem. This objective will allow us to establish methods for enhancing milk quality, evaluating the long-term sustainability of these methods, and devising long-term sustainable approaches for production of high quality milk. **Objective 3 -** We acknowledge that economic and/or non-economic factors may limit the number of producers that will utilize the tools developed to assist with mastitis/milk quality-related management decisions. However, we anticipate that the pressure of new regulations on SCC and effective use of on-farm demonstrations planned as part of this grant proposal will promote widespread adoption of these tools. **Objective 4** - Success may be limited by a lack of interest in SE dairy programs; however, the perception of a lack of interest in dairy-specific programs may be driven more by the lack of dairy-specific educational programming for veterinarians, industry professionals, and students rather than true lack of interest among these targeted groups.

SQMI Assessment: The goal of SQMI is to improve the knowledge and skills of dairy producers, their employees, dairy practitioners, extension agents, and affiliated industry personnel so that producing high quality milk is not a limitation for sustaining the dairy industry in the SE. Our expected outcomes are: 1) increased knowledge of best management practices by all groups, 2) improved practice of these strategies by producers, 3) greater milk production, 4) enhanced milk quality, 5) increased proportion of farms producing high quality milk, 6) greater milk revenues as a result of higher milk production and enhanced quality, and 7) greater sustainability of the SE dairy industry. To assess our progress and ability to deliver these outcomes, we will use a series of tools that evaluates different stages and aspects of the program. These include: 1) pre- and post-surveys administered to a select group of producers to determine their ability to make informed decisions about adopting mastitis management concepts, their ability to calculate the economic impact of mastitis on their farms, whether their values have changed towards best management practices, and barriers they perceive to adoption of control practices. 2) Tracking of SQMI and relevant DAIReXNET statistics such as frequency and length of use. 3) Pre- and post-surveys of county agents, industry personnel, and veterinarians to determine their ability to provide knowledgeable and confident advice to dairy producers, inclusion of developed material in their websites, newsletters, and other publications, and if best management strategies are being implemented by their constituents. 4) Written surveys to assess management practices employed by producers will be conducted during the 1^{st} and 5^{th} years to identify rate and progress in adoption of best management practices. 5) Track whether students who participate in internship programs remain in the dairy industry. 6) Annual assessments of bulk tank milk quality, milk production, revenues, and farm numbers throughout the SE. These and additional measures are located in the **SQMI Logic Model**. To ensure that SQMI remains on track, monthly conference calls and annual meetings will be held to determine progress on deliverables from each objective. For additional details, refer to the **SQMI Management Plan** and the **SQMI Logic Model**. Perhaps just as critical to the above assessments, will be the annual evaluation of SQMI by the External Advisory Panel, which contains members representing dairy producers, milk processors, industry representatives, extension, and government regulatory agencies. This will be an excellent gauge of the effectiveness of SQMI and is detailed further in the **SQMI Management Plan**.