Illinois Livestock Integrated Focus Teams
(IL LIFT)
2009 SRI Final Report

Principle Investigator

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Executive Summary

The Illinois Livestock Integrated Focus Teams (IL LIFT) project indentified four key areas of needs in the livestock area in response to stakeholder and producer concerns (a total of six were listed). The University of Illinois Extension Animal Systems Team developed research teams including campus staff in the Department of Animal Science at the University of Illinois and Southern Illinois University and Extension field staff to direct each of the projects with budget ranging two to four years to complete phases. These projects are listed below.

Focus 1. Illinois ***livestock facilities*** modernize and expansion facing state requirements for manure handling, consumer acceptance, community reaction, and economic impact on their facilities.

Focus 2. Ethanol by-product feeds will be abundant in Illinois and in the Midwest as new plants come on line.

Focus 3. Feeding systems that utilizes high quality ***intensively managed pasture systems*** with residual forages as alternative winter feeds to low production costs.

Focus 4. Animal identification is a national concern for producers, processors, and consumers to improve animal health, traceability of livestock products, meat and milk quality, and manage livestock using individual animal data.

A fifth funded phase was to develop electronic web based tools and web sites to deliver the data to clientele and stakeholders to insure results were available.

The livestock compliance was the highest successful focus area which collected on-farm data from swine farms. Illinois Manure Management Plans web site was developed and launched on the University of Illinois Extension web site. This project has made excellent progress and will have impact with stakeholders and clients. This phase continues to grow and expand under Dr. Ted Funk and Mr. Randy Fonner as they hold certification program, participate in the Midwest Manure Handler workshop, and expanding their web-based material. This program will continue as a statewide initiative.

The use of distillers grains and by-product feeds continues to be accessed on-line with statewide programs for stakeholders and clientele. The program continues to be delivered by Dr. Hans Stein (swine), Dr. Larry Berger and Dave Seibert (beef), and Dr. Mike Hutjens (dairy) as livestock producers searched for economical feed sources. A pricing tool to rank nutrient costs has been placed on the I-LIFT and FARm.DOC web sites. This program can stand alone and continue to be used in the future without additional funds. This focus continues to be popular based on website usage.

Forage quality in pasture-based systems collected data from several cooperating livestock facilities. Field days and tours were held to allow sheep, beef, and dairy managers to observe the pasture based systems and forage species. The data were statistically evaluated data and published in the 2009 IL Dairy Report and placed on the I-LIFT and pasture website. This project was challenging as Ed Ballard retired during the four years with Dr. Sexten leading the project and accepted at the University of Missouri. Ed Ballard, area educators, and campus faculty continue to present pasture data around IL and the U.S.

Animal identification focus was expanded into a statewide program with support from IL Dept of Agriculture, Illinois Milk Producers Association, and USDA premise identification program. This focus experienced personnel changes as Eric Reid, a graduate student, left in 2007 and Dr. Geoff Dahl accepted a position at the University of Florida. Additional data are anticipated to be available in2009-2010. Another limitation for animal identification has been the livestock producers resisting mandatory farm and animal identification. This focus continues to be a critical area as it involves food safety, disease livestock trace-back, and source of origin (consumer concerns and interest). The livestock producer must see value using animal identification to health monitoring, animal fertility, and digestive/rumen pH monitoring.

Objectives and Goals

Focus 1. As Illinois livestock facilities modernize and expand, they face state requirements for manure handling, consumer acceptance, community reaction, and economic impact on their facilities. The objectives are to access compliance by current large livestock facilities, reasons for non-compliance, and step to improve compliance and its impact on the community.

Focus 2. Ethanol by-product feeds will be abundant in Illinois and in the Midwest as new plants come on line. Livestock producers and agri-business personnel will need research results, guidelines, pricing guidelines, and recommendations to effectively use locally produced by-products.

Focus 3. Livestock producers (sheep, beef, and dairy managers) have renewed interest in low input forage based feeding systems that utilizes high quality intensively managed pasture systems with residual forages as alternative winter feeds to low production costs. Field research data, on-farm demonstrations, and current guidelines will improve Illinois livestock economics.

Focus 4. Animal identification is a national concern for producers, processors, and consumers to improve animal health, traceability of livestock products, meat and milk quality, and manage livestock using individual animal data. The goal is to develop simple, effective, and permanently identified animals from birth to market. With new emphasis from USDA to trace animals from farm to market, this focus has become a state and national priority.

Highlights and Accomplishments

1. Focus 1 (livestock compliance) completed collection of on-farm data from swine farms. Illinois Manure Management Plans web site was developed and launched on the University of Illinois Extension web site. This project has made excellent progress and will have impact with stakeholders and clients. This phase continues to grow and expand under Dr. Ted Funk and Mr. Randy Fonner as they hold certification program, participate in the Midwest Manure Handler workshop, and expanding their web-based material.

2. Focus 2 (use of distillers grains) was completed in 2006. This area continues to be accessed on-line with statewide programs for stakeholders and clientele by Dr. Hans Stein (swine), Dr. Larry Berger and Dave Seibert (beef), and Dr. Mike Hutjens (dairy) presenting updates as corn prices reached $7 a bushel and livestock producers searched for economical feed sources. Dave Seibert, area livestock beef educator, has committed several of his pricing tools and update ethanol and corn by-product feed resources to be placed on the I-LIFT web site in 2009-2010 using the remaining roll-over funds. This phase of the project will be completed in 2009-2010 under the direction of Mike Hutjens.

3. Focus 3 (forage quality in pasture-based systems) completed collection of data and has been summarized in 2008. Dr. Justin Sexten has statistically evaluated data with a paper to be published in the 2009 IL Dairy Report (attached at the end of the report, placed on the I-LIFT and pasture website, and other mass media resources. Dr. Sexten has taken a new position as beef specialist at the University of Missouri, but completed this project. Ed Ballard, area educators, and campus faculty continue to present pasture data around IL and the U.S. including featuring the data at the 2008 IL Dairy Brown Bag seminar in March, 2008 (power points of one presentation is attached). Allen Miller will develop an economic comparison of pasture-based system. This phase of the project will be completed in 2009-2010 under the direction of Mike Hutjens.

4. Focus 4 (animal identification) was expanded into a statewide program with support from IL Dept of Agriculture, Illinois Milk Producers Association, and USDA premise identification program. Eric Reid, a graduate student, is completing his doctorial program and will have data and papers to be placed on line in 2009-2010. This phase of the project is completed with no additional research data to be collected. This phase of the project is completed except to add Dr. Reid data (he defends his thesis in mid-September, 2009).

5. Illinois Livestock Trail (former IL TRAILL web site) was redesigned in 2007 and joined the suite of University of Illinois Extension web sites. This web site continues to provide the extension and outreach platform for the four focus initiatives using IL LIFT (http://www.livestocktrail.uiuc.edu/) and PastureNet (http://www.livestocktrail.uiuc.edu/pasturenet/). A summary of Internet clientele from Sept 1, 2006 to Aug 31, 2009 is listed below with the top 50 most popular web sites are listed in the appendix.

Table 1. Summary of activities, sources of visitors, and popular web sites from Sept 1, 2006 to Aug 31, 2009.

Summary of activity		
Total visitors	54,837	
Average number visitors per day	49	
Total number of hits	358,789	
Average hits per day	327	
Source of visitors		
Total countries	49 countries	
United States (1st)	83.2%	
Canada (2nd)	2.6%	
United Kingdom (3rd)	1.7%	
Australia (4th)	0.92%	
China (5th)	0.90%	
Popular web sites in I-LIFT		
Distillers grains	12,398 hits	9,840 visitors
Distillers grain ethanol plant map	4,897 hits	4,102 visitors
Distillers economics	4,134 hits	1,247 visitors
Livestock siting/sludge boat	2,543 hits	2,291 visitors
PastureNet	1,529 hits	1,208 visitors

Individual Project Summaries

Focus 1: Livestock Facility Siting in Illinois

Principle Investors: Ted Funk and Peter Goldsmith, University of Illinois

Objectives: As Illinois livestock facilities modernize and expand, they face state requirements for manure handling, consumer acceptance, community reaction, and economic impact on their facilities. The objectives are:

1. To assess regulatory compliance by current large livestock facilities
2. Learn the reasons for non-compliance
3. Design steps to improve compliance and its positive impact on the community.

Name(s), area(s) of expertise and associated research institution(s) of investigator(s):

- Ted Funk, Extension Specialist, Agricultural Engineering, Dept. of Agricultural and Biological Engineering, UIUC

- Randy Fonner, Extension Specialist, Certified Livestock Manager Training, Dept. of Agricultural and Biological Engineering, UIUC

- Matt Robert, Visiting Research Engineer, Dept. of Agricultural and Biological Engineering, UIUC

- Jane Scherer, Extension Specialist, Urban Programs, College of ACES, UIUC

Completed and current research activities:

- In 2006 we completed the on-farm survey of livestock manure nutrient management plans and practices. The survey gave us a good snapshot of the issues with CAFO regulatory compliance, and an information source for designing our producer education efforts in subsequent years.

- In 2007 we completed the EZregs www.EZregs.uiuc.edu web site that gives producers easier access to the environmental regulations that affect livestock and crop production in Illinois. EZregs includes :

    - Dead Animal Disposal
    - Endangered Species Act
    - Federal Certification of Pesticide Applicators (40CFR171)
    - Federal Recordkeeping requirements (7CFR110)

    - Federal Worker Protection Standard (40CFR170)
    - Fence Act
    - Historic Resources Preservation Act
    - IEPA Livestock Regulations Parts 501, 506, 560, 570, & 580
    - IL Construction Site Storm Water Permit
    - IL Noxious Weeds Rules
    - Illinois Noxious Weed Act
    - Illinois NPDES General Permit
    - Illinois Pesticide Act (Rules Part 250)
    - Illinois Pesticide Act (Statutes 415 ILCS 60)
    - Livestock Facility Management Regulations -- Section 900
    - LMFA (Statutes) 510 ILCS 77/1 et seq.

- Illinois Manure Management Plans (IMMP) www.IMMP.uiuc.edu web site. This web tool was a direct result of the needs identified by the earlier phase of the ILIFT on-farm research project, which illustrated the urgency of getting producers some help with building and updating their manure nutrient management plans. Highlights of the IMMP effort:

    - Resources section. We got permission from Midwest Plan Service (www.mwps.org) to include key data tables that give producers information on manure characteristics. We accessed a host of data tables from IL NRCS that help predict feedlot runoff.

    - Calendaring feature. IMMP users can set up automatic email reminders for themselves and/or employees to perform inspections and recordkeeping.

    - Mapping. One of the tasks that limit producers the most is getting all the maps in place for a manure management plan. IMMP contains specialized drawing tools, map symbol links, and upload features.

    - Manure application rate multi-year calculators. IMMP users can access automated manure application rate and crop uptake calculations for all crop fields.

Outcomes and/or impacts of research:

An on-farm survey of livestock manure nutrient management plans and practices at 36 swine facilities throughout Illinois was conducted. Investigators sought to determine Confined Animal Feeding Operations (CAFO) regulatory compliance and recordkeeping, neighbor relations and awareness of odor nuisance potential, and storm water pollution prevention. Findings from the survey were incorporated into the state-mandated livestock producer certification training program. Forty five workshops were held from December, 2006, to March, 2009, with a total of 1670 producers, contractors, and educators.

An interactive website called Illinois Manure Management Plans (IMMP) (www.IMMP.uiuc.edu) was developed to assist producers and consultants in building and updating their manure nutrient management plans and provide for convenient recordkeeping. About 500 livestock facilities in Illinois are large enough to be required to have a manure management plan. The IMMP manure management planning tool was developed in cooperation with the Illinois Department of Agriculture, Illinois Environmental Protection Agency, and Natural Resources Conservation Service in Illinois making it possible for producers to adopt one plan that satisfies the requirements of all three agencies.

Illinois producers can also access environmental regulations affecting livestock and crop production through the newly-developed EZregs website (www.EZregs.uiuc.edu). The website provides federal and state regulations related to environmental protection; safe use of agricultural chemicals; and livestock facility construction, management, and siting.

We incorporated the findings of the ILIFT on-farm surveys into the regular state-mandated livestock producer certification training (CLM) program. We held 45 workshops throughout the state of Illinois from December, 2006 to March, 2009 with a total of 1670 producers, contractors, educators and others participated in the workshops. Although it is difficult to assign regulatory compliance improvements solely to the CLM program, the surveys have been beneficial in helping us target messages for producer training, and compliance is definitely improving compared to the pre-ILIFT years.

The administration page of the IMMP web site indicates that a significant number of producers are trying the new manure nutrient management planning tool, and IMMP is being used by producers and consultants in a range of scenarios:

(1) write a complete manure management plan, especially for small to medium operations

(2) to organize data and supplemental materials when working with consultants to complete a Comprehensive Nutrient Management Plan (CNMP) for access to cost-share funding through the EQIP program

(3) to find data needed to complete a plan begun with some other software or as part of an IL EPA NPDES permit. IEPA field staff is urging producers to become familiar with IMMP as a regulatory compliance tool.

The EZregs reference tool gets used frequently by producers, agencies, and consultants to get answers to their questions on regulations.

Unforeseen difficulties or challenges: None

Status of project: Completed as planned.

Future work is to continue to conduct training sessions for regulatory staff, consultants, agribusiness, and livestock producers on the use of IMMP and other regulatory compliance tools.

Leveraged funding: A total $40,000 for the IMMP project from ILDG, IPPA, IBA, IMPA, and IEPA.

Focus 2: Using Illinois By-Product Feed in Livestock Feeding

Principle Investigator: Larry L. Berger and Mike Hutjens, University of Illinois

Objectives: To develop an interactive website to inform livestock producers in the State of Illinois about the use of dried and wet distillers grains in livestock diets.

Name(s) and associated research institution(s): Justin Homm, University of Illinois graduate student; Dave Seibert, University of Illinois regional animal systems educator; and Mike Hutjens, University of Illinois Extension Dairy Specialist.

Completed research activities: This phase of I LIFT has been completed in 2006 including current publications on distiller's grains and their utilization in swine, dairy and beef cattle diets on the website, ethanol plants that were within a 100 mile radius of Illinois were listed with contact person, yearly production of distillers grains, products available, pricing structure, nutritive value/specifications, minimum load, and their website (if available). An economic spreadsheet from the University of Wisconsin was modified to calculate break-even price of distillers grain. In 2008-2009, a project sponsored by the Illinois Corn Board to calculate the nutrient value of by-products including commercial sources was completed by a graduate student along with Dave Seibert and Mike Hutjens. Mike Hutjens leads this effort.

Listing of products: Power points with oral presentations are available on the distillers web site along with links to the University of Missouri on weekly listing of by-products prices at the place of production (fob). Pricing by-product feeds developed by Dave Seibert and Mike Hutjens is available on IL TRAIL and FARM.DOC web sites.

Outreach activities: PowerPoint oral presentations are available including swine, dairy, and beef. Programs continue to be presented to stakeholders in IL by University of Illinois by Dr. Hans Stein, Dr. Larry Berger (now at the University of Nebraska), Dr. Mike Hutjens, Dr. Teresa Steckler, Dave Seibert, and Dave Fischer. This phase continues as more corn co-products are appearing in the market place (corn barn, modified corn distillers grain, and high protein corn by-product.

Leveraged funding: Dave Seibert obtained a $2200 grant from the Illinois Corn Board to develop the break-even spreadsheet program to determine nutrient value of by-product feeds including shrink and transportation costs.

Focus 3: Using Illinois Forages Based on Pasture Based System.

Principle Investigator: Mike Hutjens, University of Illinois, Ed Ballard, University of Illinois, and Justin Sexten, University of Missouri.

Objectives and goals: To compare and contrast the relative economic value of integrating grazing animal systems into a conventional short-term crop rotation system. There are several alternative technologies available that can increase animal performance, with reduced input costs of forage-based systems and their impact on crop production systems. Another aspect is year around grazing systems for different livestock species. Detailed costs and expenses are being collected and analyzed.

Name(s) and associated research institution(s):

Ed Ballard, University of Illinois Extension regional animal systems educator; Jim Morrison, University of Illinois Extension forage educator, Rockford; and Allen Miller, University of Illinois Extension campus educator, Animal Sciences Department.

Producer cooperators: Terry and Elmer Becherer, Bradley Blackburn, Dudley Smith Initiative, John Herbert, Zane Schneider, Cliff Schuette, Steve Schwoerer, and Indian Knoll Cattle (Kevin and Penny Bliler).

Completed and current research: Agronomic and economic grazing data collection has been completed at the University of Illinois Dudley Smith Farm, Schuette Beef Farm, Becherer Sheep Farm, Steve Schwoerer Dairy Farm; John Hebert Farm, and Brad Blackburn Farm under the leadership of Ed Ballard. Forage oat variety trials were conducted in DeKalb Research Station to evaluate the influence of forage oat variety and seeding date on forage yield under the leadership of Jim Morrison. This data has been published in the Illinois Dairy Days and presented at forage meetings. The outreach aspect of this project continues.

Summary of results

One forage sample per paddock was taken monthly during the growing season from fall 2003 through fall 2007. Samples represented forage available for grazing either commercial beef cow-calf (3), beef stocker (1), lactating dairy cows (2), and commercial sheep (1) at seven producer locations across central and southern Illinois. Counties where forages were sampled are highlighted in Figure 1. Samples were delivered to a commercial testing laboratory and evaluated for quality using NIR analysis.

Samples were classified by primary, secondary and tertiary forage species by visual evaluation at sampling or based on seeding information. Data from individual forages with common growth and management characteristics were summarized collectively and presented in bold text at the top of each table. Specific forage combinations included in summarized data are listed below the general forage classification. Forages with less than 10 observations were excluded from the data set. Data are presented as collective means ± standard deviation of similar forage types across years, time of year, and locations.

Pasture systems are variable due to weather, location, forage specie, and grazing management systems. Due to limited sample replication within growing seasons, forage types, and producer locations these results should not be utilized as a definitive forage quality evaluation in managed-grazing systems. Nonetheless these data represent field setting and producer observed forage quality in managed grazing systems and can be used as a guide in developing forage systems suited to specific livestock nutrient needs.

Cool season grasses with and without legumes comprised 476 of the samples analyzed as shown in Table 1. Cool season forages provide the foundation of Illinois grazing systems. These forages provide abundant growth in spring and significant re-growth in the fall. When considering alternative forage systems producers should focus on opportunities to fill summer and winter gaps in cool season forage production.

Pastures with legume components of red and/or ladino clover offered greater crude protein and energy components with lesser fiber than grass pastures without legumes. Crude protein presented in both mixed pastures and grass only pasture exceeds the needs of both growing and lactating livestock. Forage energy density would limit animal productivity based on these data.

Legumes ability to provide greater energy with less fiber is advantageous to all livestock species. The additional nitrogen fixation offers opportunities to reduce nitrogen fertilization needs in managed grazing systems. Endophyte infection level is not represented in this data, presence of legumes in endophyte infected tall fescue pastures offer the opportunity to dilute endophyte effects on performance.

Table 1. Cool season perennial grasses and legumes

Forage	n	DM, %	CP, %	ADF, %	NDF, %	TDN, %
Cool season grass + legumes	367	24.9 ± 8.3	20.8 ± 4.1	32.4 ± 5.4	57.4 ± 6.7	64.0 ± 5.8
Tall fescue + clover	139	25.9 ± 8.5	19.8 ± 3.9	32.6 ± 5.2	57.6 ± 6.2	63.8 ± 5.6
T. Fescue, Orchardgrass + clover	95	24.3 ± 8.2	20.4 ± 4.3	33.5 ± 5.1	58.4 ± 6.5	62.9 ± 5.5
Orchardgrass, P. Ryegrass + clover	76	23.2 ± 7.1	21.6 ± 4.3	32.6 ± 5.8	58.6 ± 7.4	63.8 ± 6.2
Orchardgrass + clover	54	25.6 ± 9.6	22.9 ± 3.1	29.8 ± 4.6	53.5 ± 5.7	66.8 ± 4.9
Cool season grass	109	29.0 ± 12.3	18.2 ± 4.9	34.2 ± 5.8	61.9 ± 5.7	62.1 ± 6.2
Tall fescue, novel endophyte	72	28.3 ± 11.2	17.3 ± 4.9	34.8 ± 5.6	61.4 ± 5.7	61.5 ± 6.0
Orchardgrass + Festolium	33	28.5 ± 12.5	20.5 ± 4.3	32.7 ± 5.9	62.8 ± 5.8	63.7 ± 6.3

Cereal and cool season annuals were managed for grazing in late fall, winter and early spring. Due to limited samples spring and fall planted forages were not separated in the analysis shown in Table 2. Forage quality of cereals and cool season annuals was greatest for all forage types observed.

Quality forage available during a slow growth period of the year for perennial forages offers livestock producers who traditionally feed poor quality stored forages during these periods several opportunities. Cow-calf producers may retain calves in a backgrounding system to achieve greater post-weaning gain while minimizing cost of gain and yardage expenses. Beef, dairy and sheep producers alike can extend early and late grazing periods using these forages while maintaining productivity due to greater forage quality. Cereals and cool season annuals in this dataset were utilized as late as mid-February. Producer use of cereal and brassica mixtures seeded in August and September has grown increasingly popular as an option to extend the grazing season and utilize idle acres during late fall and winter months. Forage quality observed in these data demonstrates these forage combinations offer not only a longer grazing season but provide excellent forage quality during this period.

Table 2. Cereals, cool season annuals and brassicas

Forage	n	DM, %	CP, %	ADF, %	NDF, %	TI
Cereals and cool season annuals	**136**	**21.0 ± 8.7**	**24.2 ± 5.4**	**24.6 ± 6.2**	**49.3 ± 8.0**	**72**
Cereal rye	74	21.3 ± 7.0	24.8 ± 5.8	23.7 ± 6.6	50.0 ± 8.2	73
Oats	24	19.5 ± 7.6	23.6 ± 4.5	25.1 ± 7.1	48.0 ± 8.9	71
Annual ryegrass	17	18.8 ± 7.4	23.0 ± 5.4	25.5 ± 5.5	47.1 ± 8.2	71
Wheat	16	25.6 ± 16.3	22.5 ± 4.0	26.4 ± 4.3	49.1 ± 6.1	70
Cereal and Brassica	**95**	**19.0 ± 8.2**	**22.1 ± 6.3**	**28.6 ± 7.9**	**42.4 ± 8.9**	**68**
Oat, cereal rye + brassica	68	21.6 ± 8.1	20.5 ± 6.0	30.5 ± 7.8	43.6 ± 9.7	66
Oat + brassica	25	12.1 ± 3.4	26.2 ± 5.4	23.9 ± 6.0	40.5 ± 6.8	73

Summer annual use among producers has traditionally focused on hay production due to establishment and seeding expenses and high forage yield. As managed grazing systems developed and pasture utilization rates improved use of warm season annuals in grazing programs expanded. In these data, summer annuals were used to provide grazing during the summer slump period of cool season pastures, transition pastures from cropland to permanent pastures and part of a pasture rotation where cereals and winter annuals were replaced by summer annuals.

Regardless of use summer annual forages provide forage quality (Table 3) comparable to cool season forages during a hot and typically dry period where cool season perennial and annual pastures require longer rest periods and forage growth slows.

Table 3. Summer annual forages

Forage	n	DM, %	CP, %	ADF, %	NDF, %
Summer annual	**102**	**18.2 ± 5.7**	**18.3 ± 4.6**	**33.1 ± 5.1**	**61.3 ± 7.6**
Sorghum sudangrass	45	19.7 ± 6.9	19.1 ± 4.1	31.7 ± 3.9	59.5 ± 5.2
Pearl millet	21	15.7 ± 4.3	19.2 ± 4.8	33.7 ± 4.6	60.5 ± 6.6
Sudangrass	14	18.4 ± 4.0	15.1 ± 4.2	36.0 ± 7.2	65.8 ± 10.7
Sorghum sudangrass, BMR	12	16.8 ± 4.1	18.8 ± 5.4	32.5 ± 5.2	62.7 ± 8.5
Sudangrass, BMR	10	18.1 ± 4.6	16.5 ± 4.7	34.4 ± 5.4	63.3 ± 10.5
Summer annual + brassica	**12**	**15.6 ± 3.3**	**22.9 ± 5.3**	**29.5 ± 5.7**	**51.2 ± 11.3**

The miscellaneous forages reported in Table 4 are samples from single producer locations and where specific forages were not comparable to previously discussed forage types. Alfalfa and alfalfa and clover mix was utilized in a dairy operation as a flexible pasture where forages were used for either haying or grazing and varied depending on forage supply and time of year. Later hay cuttings of alfalfa may become difficult to justify as harvest costs per ton increase due to lower yield. Harvesting these later cuttings by grazing offers opportunity to optimize utilization and harvest cost.

Red clover was utilized as a companion crop to winter wheat and harvested either by grazing or haying. Stubble clover hay is commonly harvested late in the growing season with pure clover hay harvest the following year in a beef operation used in this data set. Use of clover in a crop rotation provides nitrogen to subsequent crop while providing forage and ground cover.

Eastern gamagrass and kura clover was the only warm season perennial grass and legume combination present in the dataset. These forages were selected to provide forage during the summer slump while supplying nitrogen to Eastern gamagrass from a perennial legume, kura clover in this case. As expected recorded eastern gamagrass and kura clover forage quality was not as great as cool season forages however forage supply was available during times of slowed growth of cool season forages.

When comparing an eastern gamagrass and kura clover system to a summer annual forage system the perennial system minimizes establishment risk and offers opportunity to spread expenses over longer time period. However to realize the longer stand life producers must provide adequate rest and residual growth to warm season forages whereas annuals can be fully utilized at the end of the growing season. Another drawback to the perennial warm season system is number of grazing days per acre is restricted relative to alternatives. In winter/summer annual rotations land is utilized for two forage crops and in cool season perennial systems pastures can be grazed two times as many days relative to warm season perennials each year.

Outcomes and impacts: Forage testing indicates forage quality of managed grazing systems is sufficient to maintain a cow-calf enterprise. High production enterprises such as lactating ewes and dairy cows or growing calves may require energy supplementation to support desired performance. Economic data summarization is ongoing, preliminary results suggest complete utilization of annual forages is required to compete with perennial forages. A total of 764 forage samples have been collected, analyzed, and entered into a database with a summary paper prepared.

Unforeseen difficulties or challenges: Ed Ballard led this phase of the C-FAR project until he retired. Dr. Justin Sexten assumed leadership of one year and accepted a new position with the University of Missouri starting July 2007. Dr. Sexten summarized pasture based data. Mike Hutjens provided final administrative leadership for this focus area.

Status of project progress: Pasture initiative data collection was concluded in October of 2007. Data were summarization and dissemination. This project is completed.

Future work plan: Data collection at current cooperators locations has been completed. The forage oat variety and planting date trial has been repeated at the Agronomy Research Center during the fall of 2007. Alan Miller will summarize economic data while Justin Sexten will summarize forage quality data. Extension publications will be developed 2009 to disseminate results. The forage oat variety trial was repeated in 2007 completing three years of data collection. Results were summarized January 2008 and published in the Illinois Dairy Report.

Collaborative support / participation:

- I-LIFT pasture initiative has leveraged over $380,000 in private funding in collaboration with the Dudley Smith Initiative.

- An additional $21,900 was leveraged through the Extension Pasture and Grazing Focus Group.

- Three grants through the USDA-Risk Management Agency and Illinois Forage and Grassland Council totaling $2,182 was leveraged through I-LIFT.

- An AgriFirst Grant of $2,000 from the Illinois Department of Agriculture was leveraged through I-LIFT to assist with the Heart of America Grazing Conference program.

- Collaboration with Pennington, Ampac, and Barenbrug seed dealers in plot development has resulted in seed donation.

- Alvey Laboratory in Belleville, IL, supported I-LIFT forage testing component.

***Outreach activities*:** I-LIFT cooperators Ed Ballard and Steve Schwoerer presented I-LIFT dairy data at the 2008 IL Brown Bag Dairy TeleNet Seminars conducted by Dave

Seibert with Ed Ballard. Ed Ballard presented 16 meetings in Illinois and U.S. attended by 729 stakeholders and 8 radio programs. Allen Miller also presented I-LIFT data at the Dudley Smith field day in 2008. Ed Ballard and Allen Miller continue to present I-LIFT pasture and forage data across Illinois.

Focus 4: Animal Identification for Enhanced Food Quality and Monitoring Livestock Health.

Principal Investigator: Geoff Dahl

Objectives and goals: Animal identification is a national concern for producers, processors, and consumers to improve animal health, traceability of livestock products, meat and milk quality, and manage livestock using individual animal data. The goal is to develop simple, effective, and permanently identified animals from birth to market. Test micrometer scale electronic devices were developed as a method for permanent animal identification and physiological monitoring, with an emphasis on body temperature tracking in real time.

Name(s) and associated research institution(s): University of Illinois; Micro and Nanotechnology Laboratory, Greg Timp; IDOA working group on Animal Identification.

Completed and current research:
As production agriculture continues to head toward larger production facilities with a decreasing labor force, technologies that increase the ability to monitor animals individually without increasing labor cost become necessary to provide proper care. As animals travel through an ever expanding global economy it is also advantageous to have the ability to identify movement from location to location to speed the identification of sick animals to prevent disease spread and maintain food security. The development of the microchips used in the current experiments provide both individual animal identification and the ability to monitor body temperature. The experiments conducted with these microchips have revealed novel results and opportunities to improve the devices.

The results of these studies indicate that the BioThermo microchips correlate well with rectal temperature under normal conditions. In the first experiment positive correlation between microchip temperature and rectal temperature exists in young steers at three separate locations (ear, poll, and umbilical fold) under thermoneutral conditions. The positive correlation was similar in both dry and lactating cattle not experiencing health events in the second experiment and the positive correlation continued in those cows before and after estrus in the third experiment. That positive correlation was repeated in a second cohort of young steers experiencing thermoneutral ambient temperature in the fourth experiment. There appears to be a repeatable positive correlation between the microchips and rectal temperature during periods of thermoneutral ambient temperature and when animals are not experiencing a health event.

The ability to detect animals in a normal state is less important than being able to determine when animals are experiencing stressors that alter their body temperature. This series of experiments has demonstrated that the microchips will deviate from mean values when changes in temperature regulation occur. Most interesting is the negative correlation of the microchips to rectal temperature during an LPS challenge as seen in the first experiment. The mechanism of that response is thought to be related to an acute stress response that shunts blood to the core, thus reducing temperature at the periphery. This phenomenon was also exhibited in the fourth experiment when LPS was given at thermoneutral ambient temperature. This was also conserved under heat stress for three out of the four steers in the fourth experiment. The fact that one steer exhibited a positive correlation between rectal temperature and the microchip temperature indicates that using microchip temperature for diagnostic purposes requires models that take individual animal differences into account.

The results of these experiments indicate that there may be some value to using the microchips in a real world application. Some animals from the second experiment exhibited a reduction in microchip temperature roughly 24 hours before parturition. This could be used to identify animals needing to move to a maternity pen around calving. After calving there was one clear example of large changes in microchip temperature nearly 2 days before the animal was clinically diagnosed with metritis. Using the data generated during the first 2 weeks of lactation a model was able to identify all animals experiencing health events, although 75% of all animals were flagged. Some animals exhibited significant changes in microchip temperature around estrus, although not enough to have significant results. There were also clear increases in microchip temperature when ambient temperature was raised beyond the thermoneutral zone. Data generated by these microchips could be used to identify animals experiencing heat stress and could hasten heat abatement strategies.

The microchip system tested is not without flaws. Currently, there is a large amount of labor needed to run the system. Temperature collection must be taken with a handheld wand which requires the user to be within reach of the animal. There is also little or no data collection and analysis software available. The data generated by these experiments indicate that data must be collected much more frequently to provide enough power to provide statistically significant results.

The results of these studies indicate that the BioThermo microchip system has great potential for use in identifying animals experiencing a range of biological changes through the use of peripheral body temperature. In order for the system to be utilized in common commercial applications, the system will require the development of longer read distances, more frequent data collection, and better data collection and analysis techniques. More research is needed to develop more robust models that take into account varying ambient conditions and individual animal variation.

Outcomes and/or impacts: Three abstracts have been published based on research supported by this grant (attached in the appendix section at the end). Eric Reid defended his doctorial thesis in the fall of 2009 resulting in additional publications to be added to web site.

Reid, E.D. and G.E. Dahl. 2005. Peripheral and core body temperature sensing using radio-frequency implants in steers challenged with lipopolysaccharide. *J. Anim. Sci.* 83(Suppl. 1):352. Abstract #554.

Reid, E.D., K.E. Karvetski, J.M. Velasco, R.L. Wallace, and G.E. Dahl. 2006. Rectal temperature measurement versus peripheral temperature sensing using radio-frequency implants in periparturient dairy cattle. *J. Anim. Sci.* 84(Suppl. 1):95. Abstract #31.

Reid, E.D., J.M. Velasco, and G.E. Dahl. 2007. Rectal versus peripheral temperature measurement using radio-frequency implants in steers challenged with lipopolysaccharide during periods of heat stress. *J. Anim. Sci.* 85(Suppl. 1):418. Abstract #550.

These abstracts will be the basis for three peer-reviewed journal articles in 2010.
In addition, there was significant outreach activity in collaboration with IDOA (see below).

***Unforeseen difficulties or challenges*:** Principal Investigator (Dr. Geoff Dahl) accepted a position at the University of Florida and his graduate student, Eric Reid, accepted a position as a New England regional specialist with a private feed company which has delayed paper completion.

***Collaborative support/participation**:* UI Food security Initiative; IDOA working group on Animal Identification; Deere & Co.; UI Micro and Nanotechnology Laboratory – Beckman Institute; SAIC (Science Applications International Corp); Illinois Milk Producers Association

***Outreach activities*:** The web site will contain summary data with publication of the doctorial thesis.

Leveraged funding: The project is being leveraged with funding from the UI Food security Initiative and funds (~$160,000) from Deere & Co. that directly support technical development of the electronic chips being used.

Appendix

Peripheral and core body temperature sensing using radio-frequency implants in steers challenged with lipopolysaccharide.

E. D. Reid* and G. E. Dahl, *University of Illinois, Urbana*.

Early detection of disease can influence timely administration of treatments, alter the health status of animals and on a larger scale, prevent the spread of disease through a herd. Immune stimulation is often manifested as elevated core body temperature, as measured by rectal temperature. Injectable radio frequency implants (RFI) are now produced with the ability to remotely monitor temperature at the site of implantation, yet the fidelity of peripheral site values relative to core temperature is unknown. We hypothesized that in response to lipopolysaccharide (LPS), patterns at three peripheral implantation sites are similar to rectal (REC) temperature patterns in weaned steers (n=4; BW 77 +/- 2 kg). These three sites were 1)under the scutiform cartilage at the base of the left ear (EAR) 2)s.c. on the midline, posterior to the poll (POL) and 3)s.c. on the midline beneath the umbilical fold (UMB). Animals were housed in controlled temperature rooms (2/room) and fed ad libitum cubed alfalfa and water and 2 kg/d of pelleted grain. Room temperature and humidity were logged every 15 min. and REC, EAR, POL and UMB temperatures were collected every 8 h daily. On d 7, 21, 22, 36 and 37, temperatures were taken every 5 min for 6 h, every 15 min for 3 h and every 30 min for 15 h. On d7 steers were placed on either short day photoperiod (8 h light:16 h dark) or long day photoperiod (16 h light: 8 h dark) and photoperiod was switched on d22. To test the RFI during a simulated immune system challenge, 0.1 ug/kg of LPS (e. coli 055:B5) was injected i.v. at 1000 h on d 22 and 37. Mean basal temperatures (°C) were REC (38.7±0.3), EAR (36.7±1.3), POL (35.9±0.7), and UMB (36.1±1.4). REC temperature rose rapidly to 40.0±0.3°C after LPS injection, but EAR, POL and UMB declined in similar fashion. The drop in peripheral temperature was biphasic and consistent among sites. These data do not support the hypothesis that core and peripheral temperature move in synchrony after LPS challenge. However, RFI have potential for use in the early detection of diseases that alter basal temperature.

Key Words: RFID, Temperature

J. Anim. Sci. Vol. 83, Suppl. 1/J. Dairy Sci. Vol. 88, Suppl. 1

Rectal temperature measurement versus peripheral temperature sensing using radio-frequency implants in periparturient dairy cattle.

E. D. Reid*, K. E. Karvetski, J. M. Velasco, R. L. Wallace, and G. E. Dahl, *University of Illinois*, *Urbana*.

The periparturient cow is challenged by changing metabolic processes driven by parturition and the ensuing lactation. These challenges leave the animal more susceptible to both metabolic and pathogenic insults. The ability to detect disease earlier may result in faster treatment times and be associated with higher treatment success. Injectable radio frequency implants (RFI) with the ability to remotely monitor temperature at the site of implantation are available. Temperatures recorded from these RFI exhibit a positive correlation with baseline rectal temperatures and a negative correlation to rectal temperature when cattle are challenged with lipopolysaccharide. We hypothesized that the RFIs, implanted under the scutiform cartilage of the ear of periparturient cows, would be positively correlated to baseline rectal temperature and would be negatively correlated to rectal temperature during a known health event. We also hypothesized that increased temperature sampling would allow for quicker identification of disease in these periparturient cows relative to traditional methods. Multiparous dairy cattle (n=40) were implanted with an RFI one wk prior to dry off. Rectal and RFI temperatures (RT and RFIT) were recorded every 12 h until –7 d before expected calving date when sampling frequency increased to every 6 hours until 14 d after calving. Ambient temperature (AMB) was also logged at 30 min intervals and was included in the statistical model. Mean RT (°C) varied throughout the day (39.7 ± 0.2, 39.3 ± 0.1, 38.7 ± 0.2, 39.9 ± 0.1) for 03:00, 09:00, 15:00 and 21:00 respectively. Mean RFIT also varied (37.7 ± 0.2, 37.5 ± 0.2, 37.6 ± 0.2, 38.1 ± 0.2) for the same time points. RFIT were positively correlated with RT (r=0.46, $P < 0.001$) and AMB was positively correlated with both RT and RFIT r=0.41 and 0.55, $P < 0.001$ respectively). A negative correlation between RFIT and RT during diagnosed health events (n=11 total; 4 metabolic, 7 reproductive) was not consistently observed therefore this approach has limited value in early disease detection.

Key Words: RFID, Temperature

Rectal versus peripheral temperature measurement using radio-frequency implants in steers challenged with lipopolysaccharide during periods of heat stress.

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Florida, *Gainesville*.

Heat stress in cattle reduces production and profit for livestock owners. Heat stress causes an increase in body temperature, which makes it difficult to identify sick animals in systems using rectal temperature as a tool to assess animal health. Injectable radio frequency implants (RFI) that can monitor temperature at the site of implantation are available and readings are positively correlated with rectal temperature (RT) during periods of heat stress. These RFI also exhibit a negative correlation with RT when cattle are challenged with lipopolysaccharide (LPS). We hypothesized that the RFIs, implanted under the scutiform cartilage of the ear of steers would be positively correlated to RT during controlled heat stress, and would exhibit a negative correlation to RT during a challenge with LPS during heat stress. To test this hypothesis, four steers (127 ± 7 kg) were moved into controlled environment chambers with individual stalls (2 steers per chamber), implanted with RFI, and allowed 2 wk to acclimate. One chamber remained at 20 C, the other was increased to 35 C starting at 0800 for a period of 48 hours. LPS was administered to all steers at 1000 on day 2. The steers were then given a 2 wk adjustment period at 20 C, and the temperature was increased in the opposite chamber, resulting in a crossover statistical design with each steer as its own ambient control. Rectal and RFI temperatures were logged at 5 min intervals. Ambient temperature was also recorded every 5 min and was included as a covariate in the statistical model. Pearson correlation coefficients for RFI and RT were 0.08 ($P=0.44$) during heat stress, 0.20 ($P=0.05$) during heat stress with LPS challenge, 0.41 ($P<0.01$) during the ambient period, and -0.42 ($P<0.01$) during the ambient period with LPS challenge. Individual response varied; some exhibited negative correlation while others exhibited positive correlation. These data do not support the hypothesis and suggest that individual response be considered when identifying models for use of RFI in temperature monitoring.

Key Words: RFID, Temperature, LPS

FORAGE QUALITY OBSERVED IN ILLINOIS MANAGED PASTURE SYSTEMS

William J. Sexten and Edward N. Ballard

TAKE HOME MESSAGES

- Samples from cool season perennial, summer annual, cereal, winter annual and legume forages indicate forage quality is suitable for moderate levels of livestock productivity.
- Adequate energy supply limits productivity of growing and lactating livestock.
- Productivity limitations ultimately are related to energy intake in one of two ways: inadequate energy density or inadequate energy supply.
- Those producers without diverse forage resources will be limited by inadequate energy supply throughout the year.

Figure 1. Forage sampling counties

INTRODUCTION

Livestock producers (sheep, beef, and dairy managers) have renewed interest in low-input forage-based feeding systems utilizing managed pasture systems and residual forages as alternative winter feeds to lower production costs. Interest in grazing-based systems continues to grow as livestock producers continue to manage increasing fuel, feed and fertilizer cost. Managed-grazing systems offer producers the opportunity to minimize these three key areas of rising input costs. This aspect of the C-FAR sponsored IL-LIFT Pasture Initiative Project focused on quantifying forage quality of managed pasture systems in several locations, under different management scenarios and livestock demands.

Data Collection and Interpretation

One forage sample per paddock was taken monthly during the growing season from fall 2003 through fall 2007. Samples represented forage available for grazing either commercial beef cow-calf (3), beef stocker (1), lactating dairy cows (2), and commercial sheep (1) at seven producer locations across central and southern Illinois. Counties where forages were sampled are highlighted in Figure 1. Samples were delivered to a commercial testing laboratory and evaluated for quality using NIR analysis.

Samples were classified by primary, secondary and tertiary forage species by visual evaluation at sampling or based on seeding information. Data from individual forages with common growth and management characteristics were summarized collectively and presented in bold text at the top of each table. Specific forage combinations included in summarized data are listed below the general forage classification. Forages with less than 10 observations were excluded from the data set. Data are presented as collective means ± standard deviation of similar forage types across years, time of year, and locations. Pasture systems are variable due to weather, location, forage specie, and grazing management systems. Due to limited sample replication within growing seasons, forage types, and producer locations these results should not be utilized as a definitive forage quality evaluation in managed-grazing systems. Nonetheless these data represent field setting and producer observed forage quality in managed grazing systems and can be used as a guide in developing forage systems suited to specific livestock nutrient needs.

RESULTS

Cool season grasses with and without legumes comprised 476 of the samples analyzed as shown in Table 1. Cool season forages provide the foundation of Illinois grazing systems. These forages provide abundant growth in spring and significant re-growth in the fall. When considering alternative forage systems producers should focus on opportunities to fill summer and winter gaps in cool season forage production.

Pastures with legume components of red and/or ladino clover offered greater crude protein and energy components with lesser fiber than grass pastures without legumes. Crude protein presented in both mixed pastures and grass only pasture exceeds the needs of both growing and lactating livestock. Forage energy density would limit animal productivity based on these data.

Legumes ability to provide greater energy with less fiber is advantageous to all livestock species. The additional nitrogen fixation offers opportunities to reduce nitrogen fertilization needs in managed grazing systems. Endophyte infection level is not represented in this data, presence of legumes in endophyte infected tall fescue pastures offer the opportunity to dilute endophyte effects on performance.

Table 1. Cool season perennial grasses and legumes

Forage	n	DM, %	CP, %	ADF, %	NDF, %	TDN, %
Cool season grass + legumes	367	24.9 ± 8.3	20.8 ± 4.1	32.4 ± 5.4	57.4 ± 6.7	64.0 ± 5.8
Tall fescue + clover	139	25.9 ± 8.5	19.8 ± 3.9	32.6 ± 5.2	57.6 ± 6.2	63.8 ± 5.6
T. Fescue, Orchardgrass + clover	95	24.3 ± 8.2	20.4 ± 4.3	33.5 ± 5.1	58.4 ± 6.5	62.9 ± 5.5
Orchardgrass, P. Ryegrass + clover	76	23.2 ± 7.1	21.6 ± 4.3	32.6 ± 5.8	58.6 ± 7.4	63.8 ± 6.2
Orchardgrass + clover	54	25.6 ± 9.6	22.9 ± 3.1	29.8 ± 4.6	53.5 ± 5.7	66.8 ± 4.9
Cool season grass	109	29.0 ± 12.3	18.2 ± 4.9	34.2 ± 5.8	61.9 ± 5.7	62.1 ± 6.2
Tall fescue, novel endophyte	72	28.3 ± 11.2	17.3 ± 4.9	34.8 ± 5.6	61.4 ± 5.7	61.5 ± 6.0
Orchardgrass + Festolium	33	28.5 ± 12.5	20.5 ± 4.3	32.7 ± 5.9	62.8 ± 5.8	63.7 ± 6.3

Cereal and cool season annuals were managed for grazing in late fall, winter and early spring. Due to limited samples spring and fall planted forages were not separated in the analysis shown in Table 2. Forage quality of cereals and cool season annuals was greatest for all forage types observed.

Quality forage available during a slow growth period of the year for perennial forages offers livestock producers who traditionally feed poor quality stored forages during these periods several opportunities. Cow-calf producers may retain calves in a backgrounding system to achieve greater post-weaning gain while minimizing cost of gain and yardage expenses. Beef, dairy and sheep producers alike can extend early and late grazing periods using these forages while maintaining productivity due to greater forage quality. Cereals and cool season annuals in this dataset were utilized as late as mid-February. Producer use of cereal and brassica mixtures seeded in August and September has grown increasingly popular as an option to extend the grazing season and utilize idle acres during late fall and winter months. Forage quality observed in these data demonstrates these forage combinations offer not only a longer grazing season but provide excellent forage quality during this period.

Table 2. Cereals, cool season annuals and brassicas

Forage	n	DM, %	CP, %	ADF, %	NDF, %	TI
Cereals and cool season annuals	**136**	**21.0 ± 8.7**	**24.2 ± 5.4**	**24.6 ± 6.2**	**49.3 ± 8.0**	**72**
Cereal rye	74	21.3 ± 7.0	24.8 ± 5.8	23.7 ± 6.6	50.0 ± 8.2	73
Oats	24	19.5 ± 7.6	23.6 ± 4.5	25.1 ± 7.1	48.0 ± 8.9	71
Annual ryegrass	17	18.8 ± 7.4	23.0 ± 5.4	25.5 ± 5.5	47.1 ± 8.2	71
Wheat	16	25.6 ± 16.3	22.5 ± 4.0	26.4 ± 4.3	49.1 ± 6.1	70
Cereal and Brassica	**95**	**19.0 ± 8.2**	**22.1 ± 6.3**	**28.6 ± 7.9**	**42.4 ± 8.9**	**68**
Oat, cereal rye + brassica	68	21.6 ± 8.1	20.5 ± 6.0	30.5 ± 7.8	43.6 ± 9.7	66
Oat + brassica	25	12.1 ± 3.4	26.2 ± 5.4	23.9 ± 6.0	40.5 ± 6.8	73

Summer annual use among producers has traditionally focused on hay production due to establishment and seeding expenses and high forage yield. As managed grazing systems developed and pasture utilization rates improved use of warm season annuals in grazing programs expanded. In these data, summer annuals were used to provide grazing during the summer slump period of cool season pastures, transition pastures from cropland to permanent pastures and part of a pasture rotation where cereals and winter annuals were replaced by summer annuals.

Regardless of use summer annual forages provide forage quality (Table 3) comparable to cool season forages during a hot and typically dry period where cool season perennial and annual pastures require longer rest periods and forage growth slows.

Table 3. Summer annual forages

Forage	n	DM, %	CP, %	ADF, %	NDF, %
Summer annual	**102**	**18.2 ± 5.7**	**18.3 ± 4.6**	**33.1 ± 5.1**	**61.3 ± 7.6**
Sorghum sudangrass	45	19.7 ± 6.9	19.1 ± 4.1	31.7 ± 3.9	59.5 ± 5.2
Pearl millet	21	15.7 ± 4.3	19.2 ± 4.8	33.7 ± 4.6	60.5 ± 6.6
Sudangrass	14	18.4 ± 4.0	15.1 ± 4.2	36.0 ± 7.2	65.8 ± 10.7
Sorghum sudangrass, BMR	12	16.8 ± 4.1	18.8 ± 5.4	32.5 ± 5.2	62.7 ± 8.5
Sudangrass, BMR	10	18.1 ± 4.6	16.5 ± 4.7	34.4 ± 5.4	63.3 ± 10.5
Summer annual + brassica	**12**	**15.6 ± 3.3**	**22.9 ± 5.3**	**29.5 ± 5.7**	**51.2 ± 11.3**

The miscellaneous forages reported in Table 4 are samples from single producer locations and where specific forages were not comparable to previously discussed forage types. Alfalfa and alfalfa and clover mix was utilized in a dairy operation as a flexible pasture where forages were used for either haying or grazing and varied depending on forage supply and time of year. Later hay cuttings of alfalfa may become difficult to justify as harvest costs per ton increase due to lower yield. Harvesting these later cuttings by grazing offers opportunity to optimize utilization and harvest cost.

Red clover was utilized as a companion crop to winter wheat and harvested either by grazing or haying. Stubble clover hay is commonly harvested late in the growing season with pure clover hay harvest the following year in a beef operation used in this data set. Use of clover in a crop rotation provides nitrogen to subsequent crop while providing forage and ground cover.

Eastern gamagrass and kura clover was the only warm season perennial grass and legume combination present in the dataset. These forages were selected to provide forage during the summer slump while supplying nitrogen to Eastern gamagrass from a perennial legume, kura clover in this case. As expected recorded eastern gamagrass and kura clover forage quality was not as great as cool season forages however forage supply was available during times of slowed growth of cool season forages.

When comparing an eastern gamagrass and kura clover system to a summer annual forage system the perennial system minimizes establishment risk and offers opportunity to spread expenses over longer time period. However to realize the longer stand life producers must provide adequate rest and residual growth to warm season forages whereas annuals can be fully utilized at the end of the growing season. Another drawback to the perennial warm season system is number of grazing days per acre is restricted relative to alternatives. In winter/summer annual rotations land is utilized for two forage crops and in cool season perennial systems pastures can be grazed two times as many days relative to warm season perennials each year.

Table 4. Miscellaneous forages

Forage	n	DM, %	CP, %	ADF, %	NDF, %
Alfalfa	18	30.8 ± 9.6	22.3 ± 3.1	29.9 ± 3.4	42.4 ± 6.2
Alfalfa + clover	14	24.0 ± 4.1	24.6 ± 1.8	25.6 ± 4.4	38.2 ± 2.7
Red clover	15	24.5 ± 6.3	22.9 ± 3.4	33.8 ± 6.4	50.7 ± 6.3
Eastern gamagrass + kura clover	45	25.3 ± 7.6	16.7 ± 4.6	37.7 ± 7.1	64.7 ± 11.4

2009 Illinois Dairy Report, pp. 4-7