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(Current Research Information System)

U.S. Dairy Forage Research Center

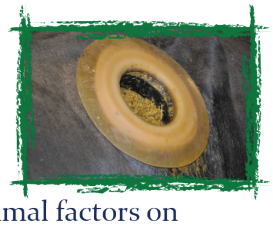
CRIS is the United States Department of Agriculture's documentation and reporting system for ongoing and recently completed research projects in agriculture, food and nutrition, and forestry.

Research at the U.S. Dairy Forage Research Center falls under these six major CRIS projects.

IMPROVING FEED EFFICIENCY OF FORAGES

Forage characteristics that alter feed utilization, manure characteristics and environmental impacts of dairy production.

UNDERSTANDING RUMEN INTERACTIONS

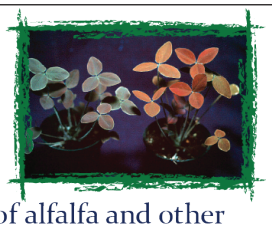


Determining influence of microbial, feed, and animal factors on efficiency of nutrient utilization and performance in lactating dairy cows.

REDESIGNING FORAGES AND FORAGE SYSTEMS

Redesigning forage genetics, management and harvesting for efficiency, profit and sustainability in dairy and bioenergy production systems

BASIC FORAGE RESEARCH



Removing limitations to the efficient utilization of alfalfa and other forages in dairy production, new bioproducts and bioenergy.

MANAGING MANURE NUTRIENTS

Improving dairy forage and manure management to reduce environmental risk.

YELLOW PERCH AQUACULTURE

Combating viral hemorrhagic septicemia and improving yellow perch aquaculture for the Great Lakes regions.

U.S. Dairy Forage Research Center
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IMPROVING FEED EFFICIENCY OF FORAGES

Forage Characteristics that Alter Feed Utilization, Manure Characteristics and Environmental Impacts of Dairy Production

This Feed Efficiency project is one of six main areas of research emphasis at the U.S. Dairy Forage Research Center

Project Number: 3655-31000-023-00
Project Type: Appropriated
Start Date: November 1, 2012
End Date: October 31, 2017

Scientists: Richard Muck
J. Mark Powell
John Grabber
Vacancy (vice Mertens)

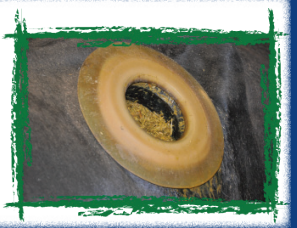
Objectives:

1. Determine the effects of dietary crude protein and forage type on feed utilization by dairy cows and heifers, in-barn methane and ammonia emissions, the production and chemistry of manure, and the impacts of these outcomes on manure nutrient availability in soils.
2. Characterize polyphenol-containing plant extracts and determine how they can be used to alter dairy cattle nitrogen efficiency, reduce in-barn emissions of ammonia and greenhouse gases and modify manure nitrogen availability in the soil.
3. Determine how silage feed additives alter rumen fermentation and feed utilization in dairy cattle.
4. Develop a functional characterization of forage fiber, accounting for physical form, fragility and digestion characteristics.

Approach:

1. Alfalfa silage, corn silage, corn grain and roasted soybeans will be 15N (nitrogen) enriched in the field and fed separately as part of a standard ration. Urine and feces will be collected from lactating cows on these rations and used in laboratory studies to estimate ammonia emissions from barn floors and soil nitrogen transformations after manure application as influenced by each feed. Feeding options for dairy replacement heifers in confinement and grazing settings will also be evaluated.
2. The ruminal-gastrointestinal digestibility of alfalfa proteins treated with tannin fractions will be determined by in vitro incubation followed by enzymatic hydrolysis. Tannin extracts will be fed to lactating dairy cows at 0 to 3% of dietary dry matter, and effects on in-barn emissions of ammonia and methane will be measured. Feces collected from this experiment will be applied to soil to measure effects on soil carbon and nitrogen cycles. Adding tannin extracts to free-stall barn floors will be studied as a means of reducing in-barn ammonia and methane emissions.
3. In vitro analyses of untreated, inoculated and formic acid-treated silages will be performed to understand how a *Lactobacillus plantarum* silage inoculant can affect rumen microbial growth. Inoculated silage extracts that appear to contain the factors affecting ruminal microbial growth will be compared to extracts from untreated silages.
4. A series of lactating cow trials will be performed to examine the effects of forage quality on energy intake, partitioning and feed conversion efficiency. Functional relationships between physical form, fragility and digestion characteristics of forage fiber will be developed and tested in ruminally fistulated cows. Differences in the mix of energy sources in lactating cow rations on intake and partitioning at different stages of lactation will also be measured.

UNDERSTANDING RUMEN INTERACTIONS



Determining Influence of Microbial, Feed, and Animal Factors on Efficiency of Nutrient Utilization and Performance in Lactating Dairy Cows

This Rumen project is one of six main areas of research emphasis at the U.S. Dairy Forage Research Center

Project Number: 3655-31000-024-00
Project Type: Appropriated
Start Date: October 10, 2012
End Date: October 9, 2017

Scientists: Mary Beth Hall
Paul Weimer
Vacancy (vice Broderick)

Objectives:

1. Maximize nitrogen use efficiency and animal performance by determining the optimal levels and qualities of dietary protein appropriate for differing base forages in dairy cattle diets, and determining the influence of polyphenol (o-quinones, tannins) or other feed additives on feed nitrogen use efficiency.
2. Assess the relationships of ruminal microbial community profile or animal genotype with animal factors including feed efficiency and lactation performance in dairy cattle.
3. Determine how the interactions among dietary components influence product formation by ruminal microbes and implications for effects on digesta passage from the rumen in order to optimize meeting animal nutrient requirements and enhancing animal performance.

Approach:

1. Feeding studies with lactating dairy cows will be performed to test the effects of different combinations of dietary forage and supplemental protein sources and the interaction of dietary tannins and crude protein level of the diet as they influence milk production and efficiency of nitrogen use for milk production. Omasal sampling will be performed in order to quantify differences among dietary treatments in flow of amino acids from the rumen. Effects of tannin and protein levels on nitrogen volatilization will also be evaluated using manure samples from this study.
2. Studies will explore the relationship of ruminal microflora profile and milk fat depression in lactating dairy cows. The impact of interactions of cow genome, lactation performance, and accrual of disease events over multiple lactations will be investigated using records of 4,000 genotyped cows. Phenotypic data will be used to establish heritability of phenotypes, and it will be adjusted for effects of age on increased risk of decreased performance/increased treated disease events.
3. In vitro fermentations will be used to investigate relationships among nonfiber carbohydrate sources and level and type of protein supply as they alter the profile, amount, and rate of fermentation product formation by ruminal microbes. The impact of the protein x carbohydrate interactions, combined with influence of changing rates of liquid passage and forage sources, will be investigated in studies with lactating cows. A series of in vivo studies with lactating cows will be conducted to explore the effects of dietary components (salts, soluble protein) on ruminal digesta liquid and dry matter proportions, total digesta weight, liquid passage rate, and water intake.

BASIC FORAGE RESEARCH

Removing Limitations to the Efficient Utilization of Alfalfa and Other Forages in Dairy Production, New Bio-Products, and Bioenergy

This Basic CRIS project is one of six main areas of research emphasis at the U.S. Dairy Forage Research Center

Project Number: 3655-21000-055-00
Project Type: Appropriated
Start Date: January 25, 2013
End Date: January 24, 2018

Scientists: Ronald Hatfield
Michael Sullivan
Wayne Zeller

Objectives:

1. Increase profitability, improve animal welfare and reduce manure production by improving the digestibility and energy conversion efficiency of forages in dairy rations by manipulating forage cell-wall biosynthetic pathways to lower indigestible residue formation, lower waste production, and develop more efficient tools for evaluating forage quality.
2. Increase profitability and reduce the amount of nitrogen-containing wastes that enter the environment by reducing protein loss during the post-harvest storage and livestock consumption of alfalfa and other forages through manipulation of forage phenolic metabolic pathways.
3. Improve forage biomass production (quantity and quality) for increased nutrient availability and novel bio-products that integrate bioenergy production with alfalfa and other forage crops to reduce input costs while improving environmental conditions.

Approach:

1. We will utilize a multidisciplinary approach combining plant physiology/biochemistry, chemistry, agronomy, molecular biology and genetics. To enhance positive characteristics of forages, work will focus on: improving cell wall digestibility under high biomass production, capturing more plant protein in products, e.g., milk and plant bio-products, while generating less nitrogen waste. Improved utilization of cell walls can be achieved through manipulation of genes involved in biosynthesis of structural carbohydrates and lignin. Small changes in cell wall composition may lead to decreased cross-linking and increased digestibility.
2. Cell wall screening methods will be used to identify chemical characteristics related to improved energy conversion efficiency. Molecular approaches will be used to modify plant biosynthetic pathways (lignification, cell wall cross-linking, structural polysaccharides) to identify avenues for altering cell wall digestibility. Efficient capture of protein nitrogen in the rumen is related to slowing protein degradation and availability of adequate digestible carbohydrate. Molecular, chemical, and biochemical approaches will be used to determine the roles of polyphenol oxidase/o-diphenols and tannins in decreasing protein degradation during ensiling and in the rumen.
3. Molecular approaches will be used to alter plants for reduced protein loss during post-harvest storage and during livestock consumption of forages. A polyphenol oxidase/o-diphenol system will be inserted into alfalfa to protect proteins during ensiling. Chemical characterization of polyphenol (e.g., o-quinones and tannins) interactions with proteins will reveal mechanisms to protect proteins from degradation and provide selection criteria for forage improvement. Multiple approaches will be used to improve forage biomass production for improved animal performance and new bio-products.

Redesigning Forage Genetics, Management and Harvesting for Efficiency, Profit and Sustainability in Dairy and Bioenergy Production Systems

This Forage project is one of six main areas of research emphasis at the U.S. Dairy Forage Research Center

Project Number: 3655-21000-056-00
Project Type: Appropriated
Start Date: January 25, 2013
End Date: January 24, 2018

Scientists: Michael Casler
Heathcliffe Riday
Geoffrey Brink
John Grabber

Objectives:

1. Develop appropriate defoliation (grazing and harvested) and nitrogen application management guidelines for temperate grass-legume pastures of the North Central and Northeastern USA to improve seasonal yield distribution, extend the grazing season, and improve the efficiency and utilization of energy inputs.
2. Improve establishment, harvest management, and storage methods to reduce nitrogen inputs, increase the profitability of crop rotations, increase the recovery of dry matter and nonstructural carbohydrates, improve the energy density of baled hays, and mitigate the negative effects of rainfall on ensiling, storage, and feeding characteristics of rain-damaged silages.
3. Improve pasture grass and legume production systems through increases in establishment capacity, persistence, productivity, resilience to climate extremes, and quality.
4. Improve profitability, conversion efficiency, and adaptability to climatic variation in forage and bioenergy crops.

Approach:

1. Solid and liquid manure applications will be evaluated in a series of grazing experiments designed to improve seasonal availability of nutrients and seasonal distribution of pasture productivity. Defoliation and manure application treatments will be applied to grass-clover mixtures to identify combinations that increase the competitiveness of red clover in mixed grazed swards.
2. High- vs. low-density plant spacing will be evaluated to determine the effect on biomass yield for high-biomass alfalfa cultivars. Gibberellin-based growth regulator treatments will be evaluated for their effect on establishment and seeding-year biomass yield for alfalfa interseeded into corn. Propionic acid preservatives will be evaluated to determine their effect on reducing spontaneous heating and nutrient loss of large-rectangular bales of alfalfa hay.
3. The comparative effectiveness of mass selection, half-sib selection, and marker-assisted half-sib selection will be determined in an empirical study designed to improve persistence and forage yield of red clover. The optimal age for selection of red clover plants will be identified.
4. The effect of lignin and etherified ferulates on persistence and forage yield will be evaluated in a series of field experiments designed to evaluate progeny with high or low levels of each cell-wall component in three grass species. Heterosis between upland and lowland switchgrass ecotypes will be evaluated in a series of experiments to quantify hybrid vigor and to identify sources of variation that contribute to variation in hybrid vigor.

MANAGING MANURE NUTRIENTS

Improving Dairy Forage and Manure Management to Reduce Environmental Risk

This Nutrients project is one of six main areas of research emphasis at the U.S. Dairy Forage Research Center

Project Number: 3655-12630-003-00
Project Type: Appropriated
Start Date: October 1, 2010
End Date: September 30, 2015

Scientists: Bill Jokela
Mark Borchardt
Wayne Coblentz
Peter Vadas

Objectives:

The overarching objective of our research project is to address current knowledge gaps in understanding and managing the nutrient cycles and pathogen transmission on modern dairy farms. Our specific research objectives are as follows:

1. Determine the effects of dairy cattle diet and dairy herd management (e.g. pasture, confinement, hybrid systems) on manure nutrient excretion, capture, recycling, and loss via gaseous emissions, leaching, and runoff.
2. Determine the effects of dairy manure management practices and cropping systems on crop production, soil properties, and loss of nutrients, sediment, and pathogens (e.g. *Cryptosporidium parvum, Salmonella spp*., and bovine diarrhea virus) in surface runoff or atmospheric emissions.
3. Determine the effects of timing and rate of dairy manure application on nutrient uptake and nutritional characteristics of fresh and harvested annual and perennial forages.
4. Develop crop management strategies to optimize the exchange of nitrogen, phosphorus, and potassium as manure and feed between neighboring dairy and cash grain farms.
5. Develop improved methods for detection and quantification of pathogens in manure, forages, and surface runoff and evaluate effects of management practices on pathogen transport and survival.

Approach:

Improved management of dairy farms requires successfully managing its nutrient flows, both to maximize nutrient use by animals and crops to optimize profit, and to minimize nutrient loss to the environment. We will investigate key aspects of nutrient cycling throughout the dairy-farm system with a variety of methods and at different scales (replicated field plots, field-scale paired watersheds, feeding trials with replicated pens of heifers, etc.). We will also examine pathogen transport and viability at different points in the dairy farm system. Our research team also has a longer-term goal, which is to integrate information across experiments to more completely describe, quantify, model, and manage the entire dairy-farm nutrient cycle. Achieving this goal will help ensure the existence of sustainable, profitable, environmentally benign dairy farming for coming decades.

YELLOW PERCH AQUACULTURE

Combating Viral Hemorrhagic Septicemia and Improving Yellow Perch Aquaculture for the Great Lakes Region

The U.S. Dairy Forage Research Center also manages an aquaculture research program in Milwaukee, WI

Project Number: 3655-31320-002-00
Project Type: Appropriated
Start Date: October 1, 2010
End Date: June 30, 2015

Scientists: Brian Shepherd
Vacancy (microbiologist)

Objectives:

The main problems in yellow perch culture are the lack of genetically defined broodstock with enhanced traits for year-round production, poor larval survival, slow growth, and disease susceptibility. These problems are being pursued via a long-term genetic selection program to produce superior germplasm and complementary studies to understand the physiological basis for performance traits of interest. This project aims to integrate genetic, molecular, physiological, and nutritional approaches to develop superior pathogen-free broodstocks and improved production methods for commercial industry. We will focus on the following objectives:

1. Develop yellow perch broodstock, define growth and viral hemorrhagic septicemia (VHS)-resistant phenotypes, characterize genetic diversity, and evaluate genotype x environment interaction for growth.
2. Characterize critical pathways involved in growth and VHS resistance in yellow perch through gene expression and physiological studies.
3. Improve early survival and methods for producing feed-trained fingerlings.
4. Develop and evaluate challenge assays, detection tools, and vaccines for protecting yellow perch and other Great Lakes region species of fish from VHS.

Approach:

1. Characterize important phenotypes and genotypes in yellow perch broodstocks. Third-generation progeny will undergo performance testing for improved growth and survival and decreased susceptibility to the viral hemorrhagic septicemia (VHS) virus.
2. Generate genomic resources to aid in development of molecular tools to genotype and quantify expression of genes involved with growth and immunity in yellow perch. Develop proteomic tools that will enable us to measure and characterize the function of critical proteins (hormones and immune markers) important to growth and immunity for this species. Lastly, in vitro methods will be used to characterize how viral proteins impact cellular antiviral recognition and response pathways that impact how yellow perch combat VHS infection, and how the virus might evade or suppress immune pathways in this species.
3. Evaluate and test use of larval specialty micro-diets as substitutes for live-prey diets to improve larval survival and standardize/reduce overall costs of producing quality yellow perch fingerlings.
4. Utilize a standardized VHS challenge model to characterize the disease process and susceptibility of perch broodstocks to VHS infection. Develop new diagnostic tools to detect VHS and use these detection tools to evaluate how vaccines and vaccination strategies increase protective immunity against VHS infection.