Fact sheet

U.S. Dairy Forage Research Center
USDA-Agricultural Research Service
Madison, Wisconsin

Providing a unique and essential contribution to bioenergy research and byproduct utilization

For centuries, farmers have been producers of food and fiber. Now they are becoming producers of fuel as America gears up to become more energy independent through bioenergy. The U.S. Dairy Forage Research Center can play a unique and essential role in bioenergy research.

Why, you may ask, should researchers who have extensive experience investigating forage digestibility in dairy cows take part in bioenergy research? There are two main reasons.

1. Twenty years of cell wall research and collaboration.

a. The USDFRC has made numerous basic cell wall discoveries that can now be applied to a broader scope that includes bioenergy production.

The cow's rumen and ethanol production are two different types of fermentation systems; both depend upon degradation of plant cell walls. There are structural and chemical factors that limit the efficient conversion of cell walls to energy – whether it be for milk or ethanol production.

The USDFRC has 20 years of experience dealing with plant cell wall chemistry, cell wall architecture, and cell wall degradation. Scientists at the Center have published over 300 papers dealing with cell wall component characterization (including component interactions) and approximately another 50 that deal with molecular aspects of cell wall degradation. These papers have been cited over 5,000 times, according to the Institute for Scientific Information.

The unique diversity of expertise at the USDFRC fosters a multidisciplinary approach to research initiatives. Those working on different aspects of cell wall research include: lignin chemist, plant physiologist/biochemist, two dairy scientists, two plant breeders, rumen microbiologist, molecular geneticist, and agronomist.

b. The USDFRC has the ability to translate basic research into applied research that leads to the commercialization of plant cultivars designed for biomass production.

Using knowledge gained from basic cell wall work, Center scientists have been working to develop new grass germplasm with decreased amounts of ferulate cross-linking and lignin. Initial selections indicate a positive impact upon cell wall degradation and utilization.

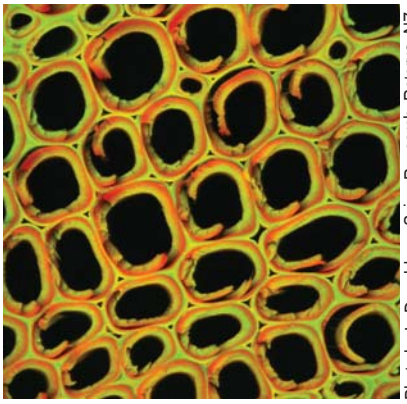


Photo by L. Donaldson, Scion Research, Rotorua, NZ

Cell walls as seen under a microscope.

Efforts are also underway to use molecular approaches to alter the lignification process in grasses (i.e., corn stover, switchgrass, ryegrass) to enhance digestibility.

Improvements in cell wall digestion should directly influence the efficiency of energy conversion from grasses for biofuels.

2. Ability to study integrated, sustainable biomass farming systems that consider byproduct utilization as well as energy production.

The production of bioenergy cannot operate in a vacuum. Both the production of biomass, and the utilization of the byproducts from their conversion to biofuels, must be integrated into existing farming systems so that changes in one area do not negatively impact animal health, farm profitability, or the environment. As the only ARS unit that can simultaneously conduct research on plants, livestock, nutrients, and farming systems – and how they all

work together – the USDFRC is uniquely positioned to investigate these 'big picture' bioenergy issues.

Plants . . .

It is estimated that agricultural resources will need to provide nearly 1 billion dry tons of biomass to meet the goal of bioenergy production by mid-21st century (DOE /USDA- Biomass Report 2005). To achieve this goal, about 40 percent of this must come from perennial crops.

Traditional forage crops should be considered in this mix for reasons beyond producing biomass for bioenergy. Perennial forages offer unique advantages in many agricultural production systems. In addition to nutritional benefits to ruminants, they provide cropping alternatives (e.g., rotations with corn) that have low environmental impact and, in many cases, help to reduce environmental problems (e.g., soil erosion, disruption of disease cycles). They also provide efficient nutrient cycling from animal waste.

Animals . . .

The DOE/USDA report indicates that the other 60 percent of biomass will come from increased grain and soybean production (for ethanol, biodiesel), crop residues, forest/lumber residues, and conversion of animal waste (manure solids) to energy.

With an increased production of corn for ethanol comes a byproduct, distiller grains. Animal nutritionists at the USDFRC have evaluated the impact of distiller grains in dairy cow rations and can further investigate the interaction of distiller grains on the utilization of the total dairy ration. For example, currently the polyunsaturated fat in corn distiller grains sets the upper limit on how much we can feed to dairy cows; in an effort to utilize more distiller grains without negatively impacting dairy cow rations, can we separate the fat and protein?

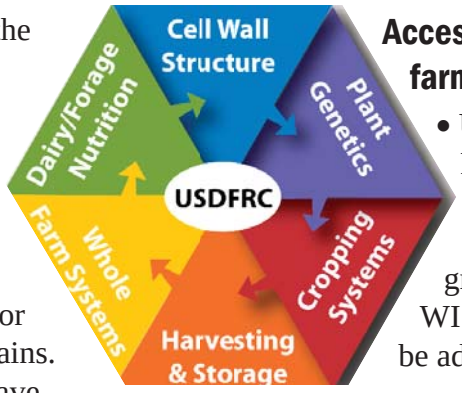
Nutrient management . . .

Newly developed research programs at the Institute for Environmentally Integrated Dairy Management (a working unit of the USDFRC) will address utilization of manure from dairy production systems for the production of energy through anaerobic fermentation.

Expertise at the Center has the capacity to evaluate how dietary interactions impact effective energy production and the optimum utilization of the nutrient rich residue. This program will be integrated into the overall USDFRC research mission to improve the utilization of forages in sustainable dairy production systems. Effective nutrient cycling is a key component of any sustainable system to prevent negative impacts from nitrogen and phosphorus.

Farming systems . . .

The USDFRC is in a unique position to look at bioenergy as it can be integrated into existing farming systems. For example: Developing bioenergy uses for rained-on hay (poor nutritive value for dairy cows); developing systems whereby perennial forage biomass crops can be integrated into corn/soybean crop rotation for improved soil conditions.



Access to two working dairy research farms already in place . . .

- U.S. Dairy Forage Research Farm, Prairie du Sac, WI – 350 dairy cows; 350 calves and heifers; 2,006 acres.
- Institute for Environmentally Integrated Dairy Management, Marshfield, WI – 270 heifers; 1,123 acres; cows to be added in 2007 or 2008.

With its multidisciplinary approach and past accomplishments in whole-farm systems and cell wall research, the USDFRC has the depth and breadth of expertise to make unique contributions that lead to efficient bioenergy production systems with positive environmental impacts.

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Last updated: March 2007