



Alfalfa Biomass Energy Research

Plant Science Research Unit

St. Paul, MN



PSRU Staff Involved in Biofuels Research

- **John W. Gronwald - biochemistry and genomics of cell wall synthesis**
- **Hans-Joachim G. Jung - cell wall composition and degradability**
- **JoAnn F. S. Lamb - alfalfa breeding and genetics**
- **Michael P. Russelle - nutrient cycling**
- **Deborah A. Samac - alfalfa pathology and genetic transformation**

Research Capacity

- **Housed in University of Minnesota offices and laboratories.**
- **Small federally-owned greenhouse facility.**
- **Field equipment for alfalfa plot work.**
- **Lab instrumentation for cell wall compositional analysis, microscopy, and molecular biology.**
- **Access to University of Minnesota facilities and field stations.**

CRIS Project

NP205 Rangeland, Pasture, and Forages

- **Forages for new uses, enhanced quality, and stress tolerance through genomics and genetic improvement - 2.9 SY, \$793,379**
- **\$288,000 from a biomass energy addition in FY2002**

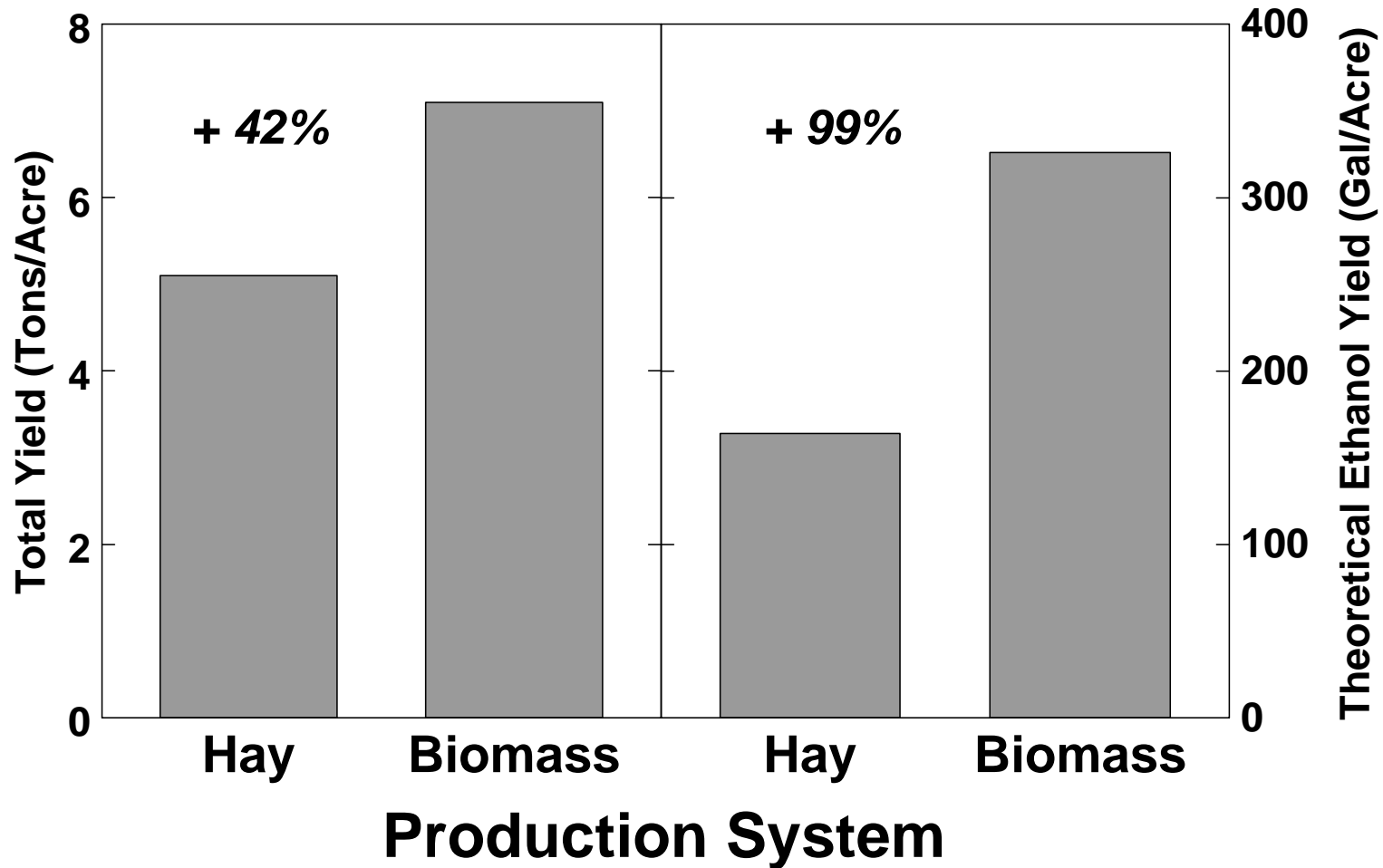
Recent Accomplishments

- ***“Biomass-Management System”*** for alfalfa.
- ***“Biomass-Type”*** alfalfa germplasm.
- **Near-infrared spectroscopy (NIRS) calibrations for alfalfa stem cell wall concentration and composition (lignin and sugar components)**
- **Alfalfa germplasm with environmentally-stable variation for lignin and cellulose concentrations.**

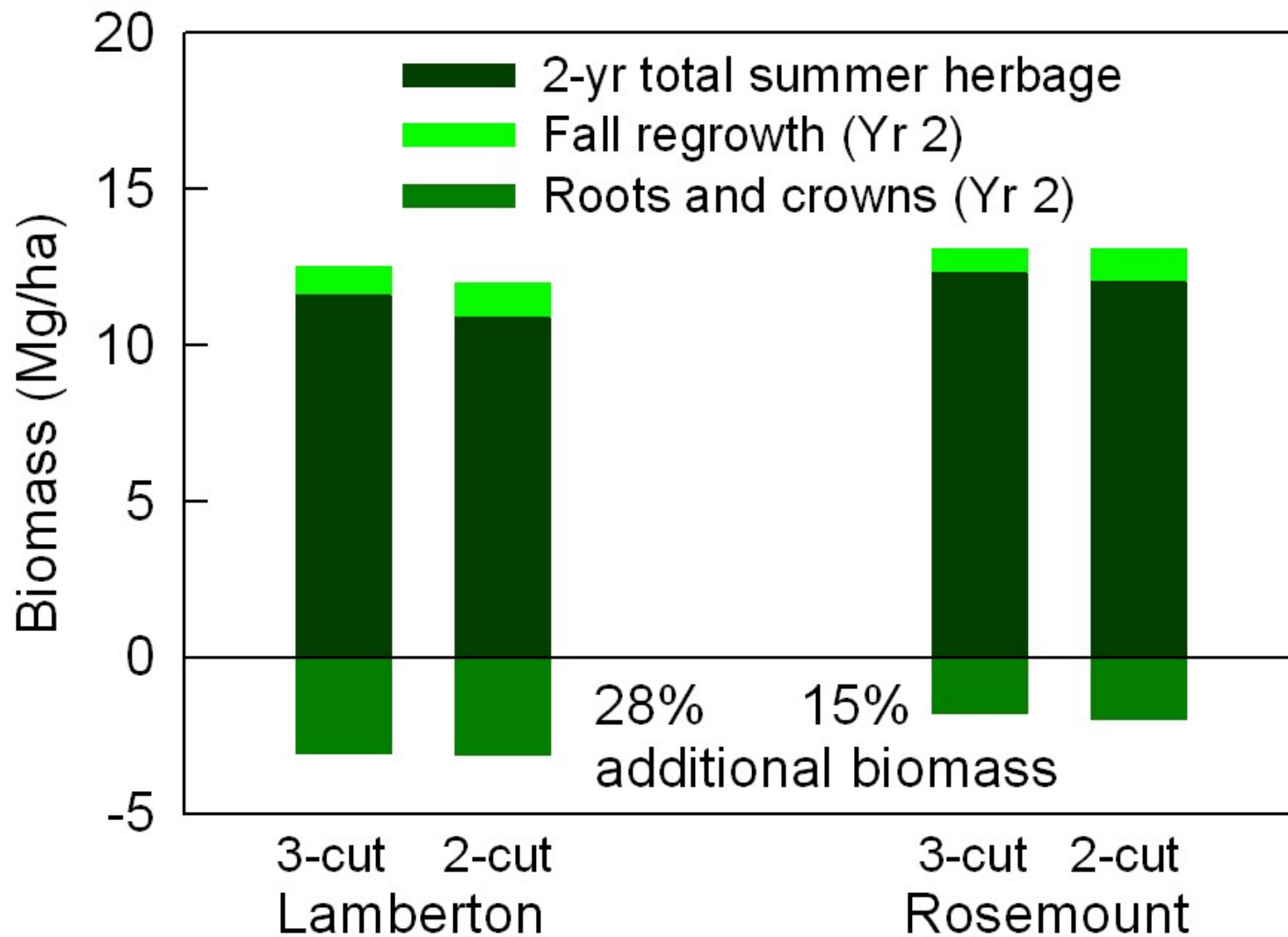
Biomass-Type Alfalfa



Advantage of Biomass-Type Alfalfa plus Biomass Management



Additional Biomass from Alfalfa Roots



Net Energy Balance

Crop (yield)	Energy input	Delivered energy	Ratio of output:input
		Million Btu/acre	
Soybeans (40 bu/a)	2.3	18.3	7
Corn grain (180 bu/a)	6.0	59.0	9
Corn stover (3.6 tons/a)	2.6	51.1	20
Alfalfa (6 tons/a)	3.0	78.2	25

Current Research

- **Heritability of cell wall traits in alfalfa.**
- **Comparison of ARS biomass-type alfalfa germplasm with industry hay and lodging-resistant lines.**
- **Gene expression related to lignin and cellulose accumulation in alfalfa stems.**
- **Evaluation of multiple biomass species for yield and cell wall composition as influenced by growth environment.**

New NP215(205) CRIS Project

Objective 1. Develop germplasm and determine genetic and biological processes that regulate forage use for bioenergy and livestock production.

- Sub-Objective 1.1: Identify genes and breeding strategies to be used for alfalfa improvement.
- Sub-Objective 1.2: Improve energy availability from forages by modifying genetic, metabolic, and developmental processes that control cell wall synthesis and breakdown.

New NP215(205) CRIS Project

Objective 2. Develop and evaluate crop management strategies to increase use of perennial forages for livestock and bioenergy and to protect the environment.

- Sub-Objective 2.1: Develop management practices and systems to optimize alfalfa composition and biomass yield for the efficient production of liquid fuels and syngas.
- Sub-Objective 2.3: Assess the interaction of management and inorganic nitrogen supply on nitrogen cycling in alfalfa and other perennial forages.

ARS Collaborations

- **Lincoln, NE and Madison, WI – Genetic and environmental impacts on switchgrass cell wall composition**
- **Peoria, IL - NIRS calibrations for predicting ethanol yield from alfalfa stems**
- **Wyndmoor, PA - NIRS calibrations for predicting syngas yield from alfalfa stems**
- **Madison, WI - Breeding for reduced lignin cross linking in perennial grasses; Heterosis effects on alfalfa yield**