The Alfalfa Research Program in USDA-ARS
The USDA-ARS Alfalfa Roadmap: Improving Alfalfa for 21st Century Farms and Markets

Deborah A. Samac

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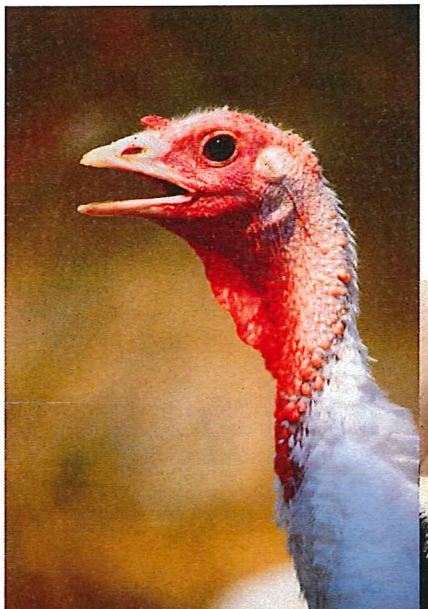
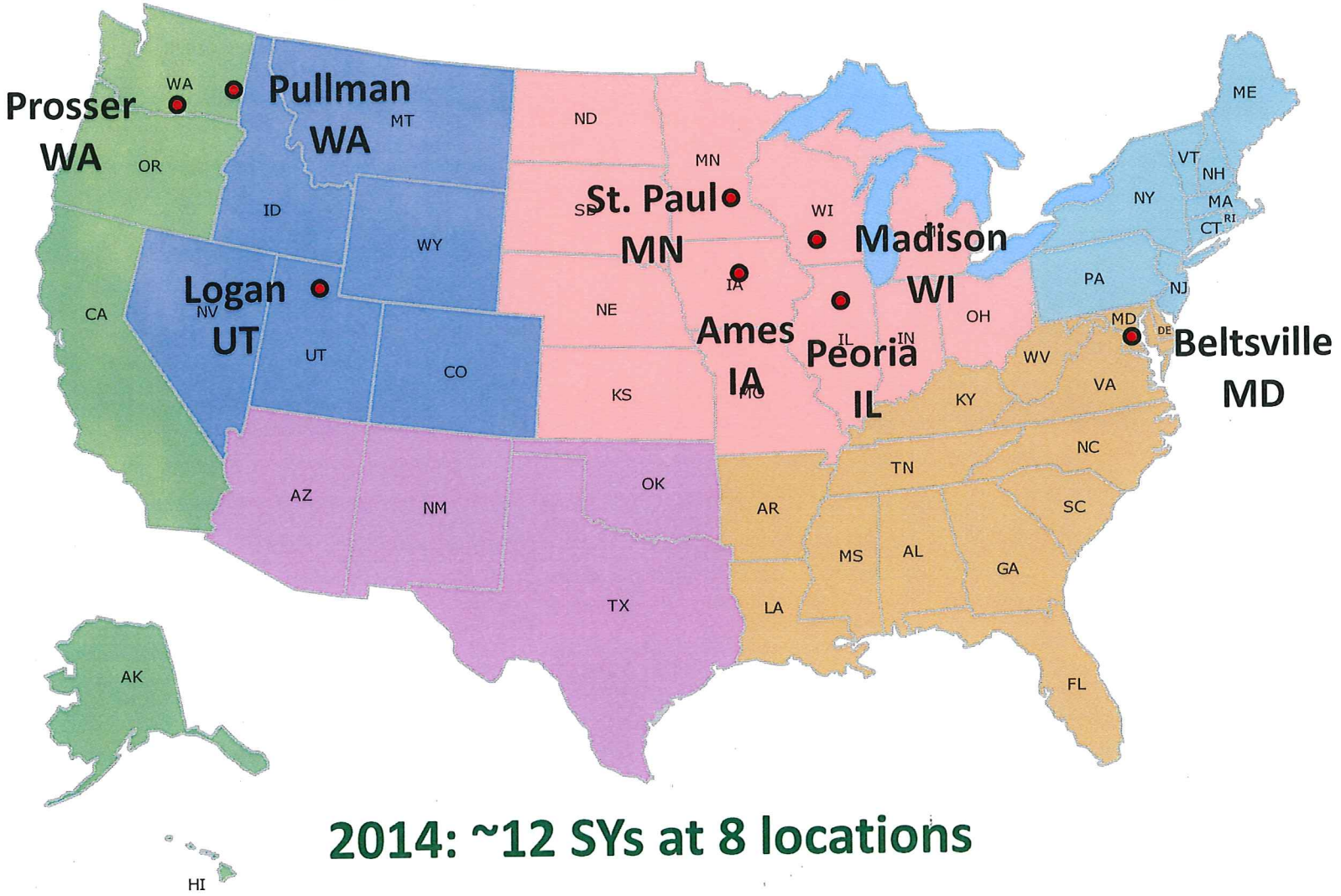


USDA

Alfalfa Research at the Agricultural Research Service



2014: ~12 SYs at 8 locations

ARS Alfalfa Scientists

St. Paul, MN (4.75 SY)
John Gronwald, Plant Physiologist
JoAnn Lamb, Res. Geneticist
Michael Russelle, Soil Scientist
Deb Samac, Plant Pathologist
John Baker, Soil Scientist
vacant (vice Vance)

Madison, WI (~3 SY)
John Grabber, Res. Agronomist
Ron Hatfield, Plant Physiologist
Bill Jokela, Res. Soil Scientist
Richard Muck, Ag. Engineer
Heathcliffe Riday, Res. Geneticist
Mike Sullivan, Molec. Biologist

Logan, UT (2 SY)
Mike Peel, Res. Geneticist
Ivan Mott, Res. Geneticist

Beltsville, MD (2 SY)
Andrea Skantar, Molec. Biologist
Lev Nemchinov, Molec. Biologist

Ames, IA
Doug Karlan,
Soil Scientist

Pullman, WA
vacant (vice Greene)

Prosser, WA (1 SY)
Long-Xi Yu, Molec. Biologist

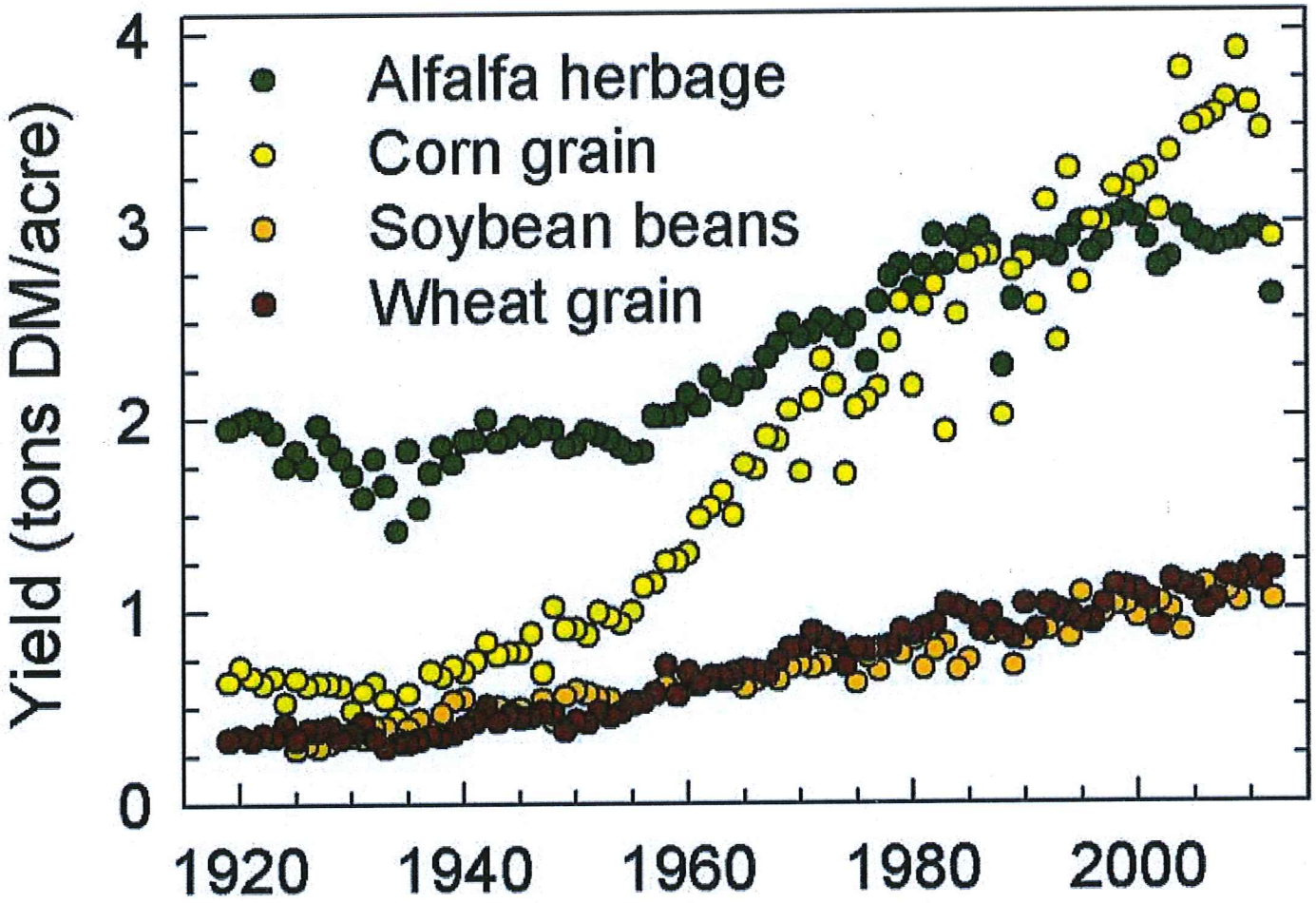
Peoria, IL
Gordon Selling, Res.
Chemist

FY '12 USDA Research Expenditures by Crop

Crop	$million	Scientist Years	# of Projects
Corn	44.6	109.9	108
Cotton	42.6	104.2	68
Wheat	42.1	95	145
Soybean	34.5	82.9	84
Apple	9.9	24	26
Tomato	8.5	19.7	43
Sorghum	8.4	22.3	27
Greens/leafy veg	6.9	15.4	19
Alfalfa	3.7	9.9	14
Sunflower	3.2	8.1	8
Carrot	0.8	1.6	5
Canola	0.7	1.6	5

Source: Agricultural Research Information System

Historical Yields of Major Crops



Eastern (non-irrigated): 2.3t/ac

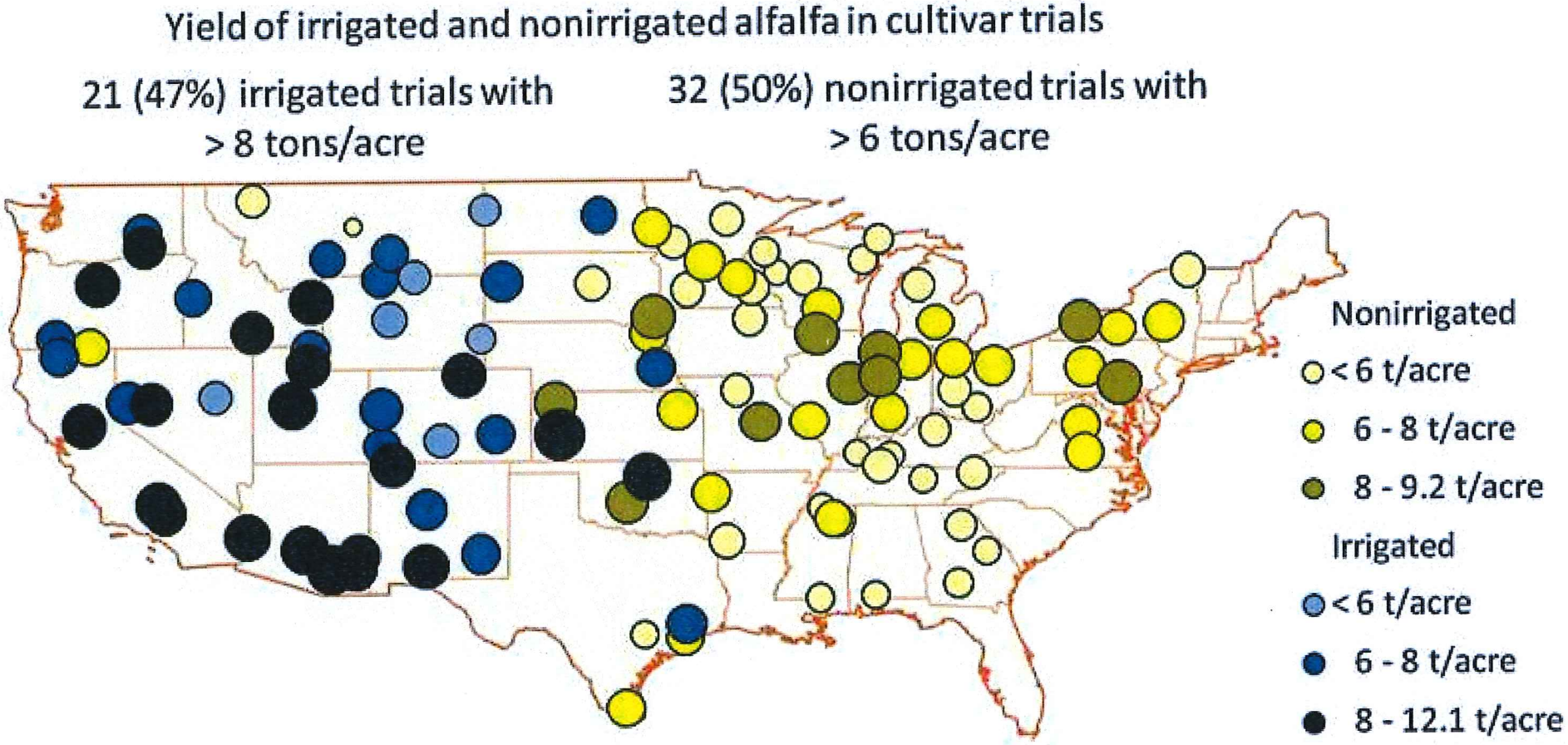
Western (irrigated): 5.5 t/ac

USDA-NASS, 2012

The Alfalfa Yield Gap

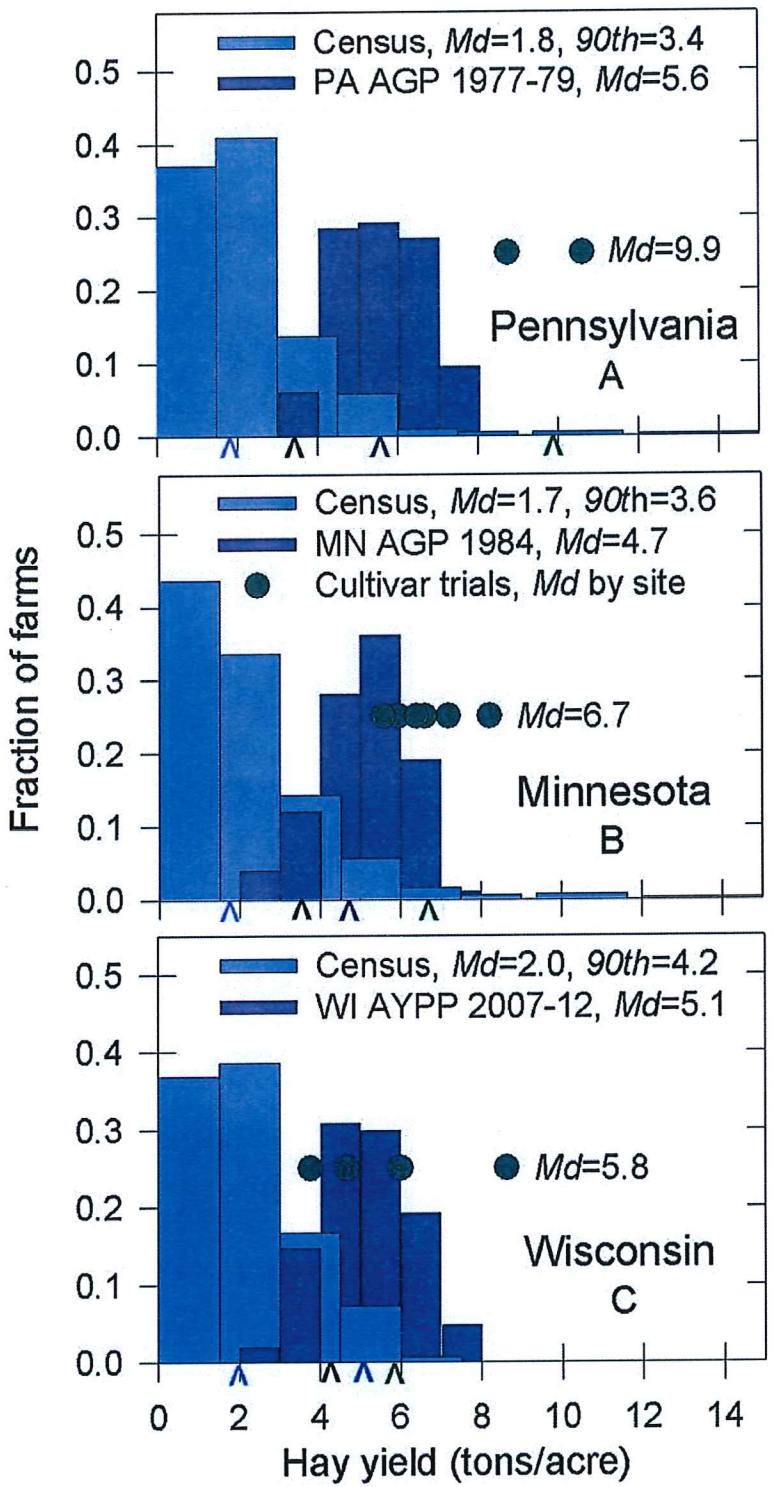
- Yield gap of 2 to 3-fold between average producers and top producers
- Feasible production with current cultivars:
  - >8 tons/acre irrigated West
  - >6 tons/acre non-irrigated East

The Alfalfa Yield Gap: Variety trials



Russelle, 2013. Forage & Grazinglands 11:1

The Alfalfa Yield Gap: On-farm yields



Consequences of Low Yield Expectations

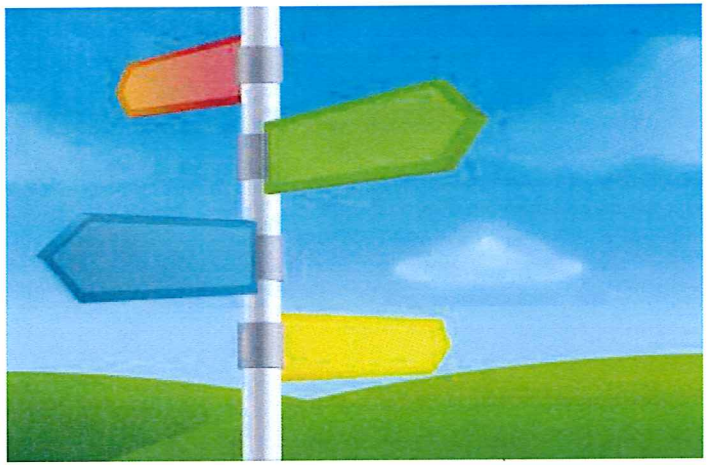
- Less investment in alfalfa seed, soil amendments, nutrients, pest control, equipment
- Delayed harvests, improper management
- National policies that undervalue contribution of alfalfa to farm and national economy

Bridging the Yield Gap

- Capture accurate yield data:
  - Yield monitors
  - Census of Ag
- Identify on-farm factors that limit yield
- Develop higher yielding alfalfa varieties

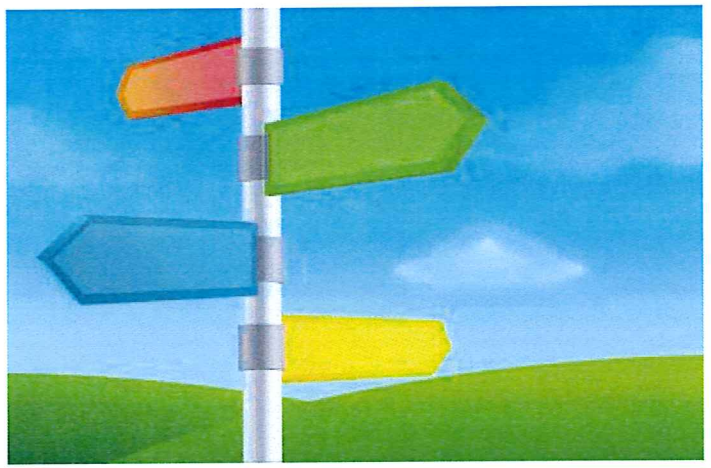
The USDA-ARS Alfalfa Road Map

- Solve problems in alfalfa production
- Coordinate research among ARS alfalfa scientists
- Identify critical needs



The USDA-ARS Alfalfa Road Map

- Route A: Genetic Improvement of Alfalfa
- Route B: Innovations in Harvesting, Processing and New Products
- Route C: Quantifying Environmental Benefits of Alfalfa



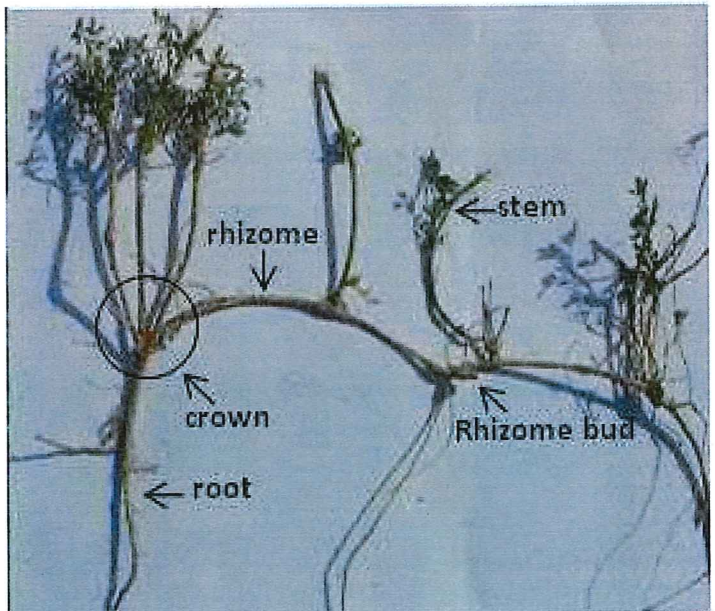
Route A: Genetic Improvement of Alfalfa

Objective: Use genetic strategies to improve alfalfa and its utilization to increase farm and ranch sustainability

- Molecular markers
- Exploit genetic diversity
- Characterization of nematodes and pathogens

Molecular Markers

- Facilitate breeding
  - Yu (Prosser): Verticillium wilt, stem nematode
  - Riday (Madison) and Lamb (St. Paul): SSR markers used for paternity testing in *sativa* x *falcata* hybrids
  - Mott and Peel (Logan): rhizomatous architecture and salinity tolerance
  - Nemchinov (Beltsville): transcription factors database
  - Samac and Lamb (St. Paul): Aphanomyces root rot

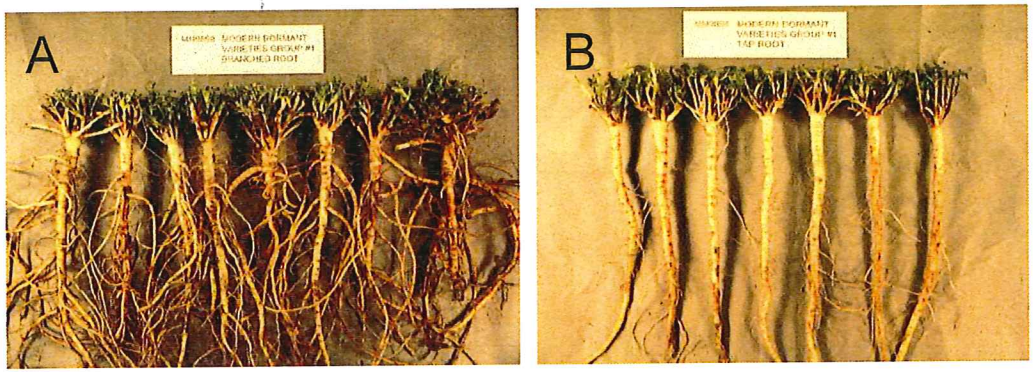


Exploit genetic diversity

- NPGS: >3,000 alfalfa accessions, 2/3 lacking phenotypic information
  - Riday (Madison): 150 accessions for agronomic traits
  - Yu (Prosser): drought tolerance
  - Samac (St Paul): ARR resistance

Exploit genetic diversity

- Selection from adapted germplasm (Lamb, St. Paul)
  - root system architecture
  - NDF digestibility
  - nitrate uptake



- Gene transfer for unique traits
  - Sullivan (Madison): PPO/o-diphenol protein protection system
  - Samac (St. Paul): antimicrobial peptides

Route A: Outcomes

- Alfalfa with improved persistence under drought and saline conditions, nematodes and pathogens
- Alfalfa with increased yield, leaf retention
- Improved nutritive value: protein quality, fiber digestibility

Route B: Innovations in Harvest, Processing and New Products

Objective: Develop harvest and storage technologies to enhance alfalfa feed quality and develop new products

- Leaf-stem separation harvesting system
- Storage practices for ensiling leaves
- Leaf and stem products

Expand Alfalfa Product Options

Novel harvesting method (Hatfield, Muck, Weimer, Digman, Madison; Karlan, Ames)

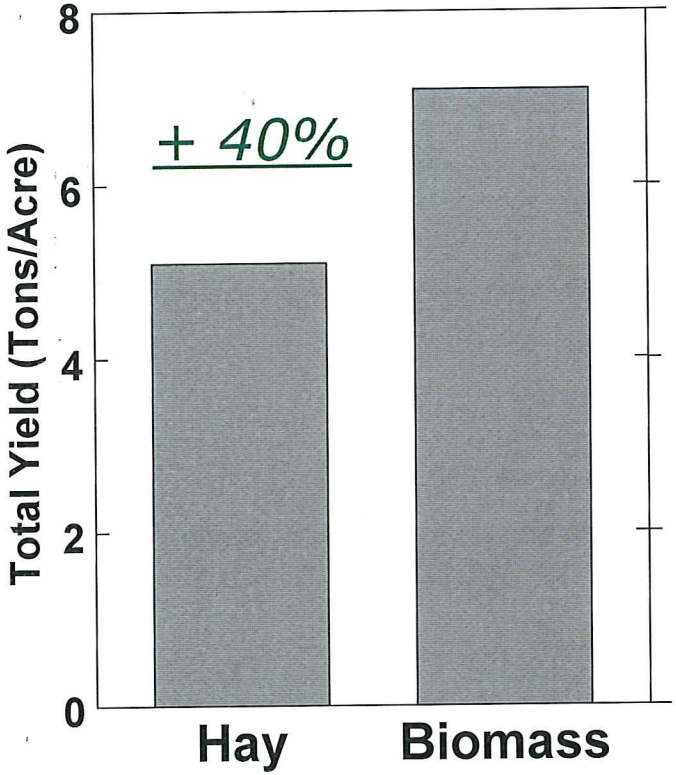
- -Reduce number of harvests
- -Reduce labor
- -Increase harvest flexibility
- -Increase product functionality and value


MILLER
PRO

Expand Alfalfa Product Options

Biomass-type alfalfa

Developed by USDA-ARS



Lamb et al. 2007. Crop Sci. 47:1407-1415.

Expand Alfalfa Product Options

Efficient separation of stem and leaf material

Stripped Leaves

- **Leaf Fraction: 60%***
- **Purity: 90% leaves**
- **Protein: 27%**
- **Fiber: 20%**

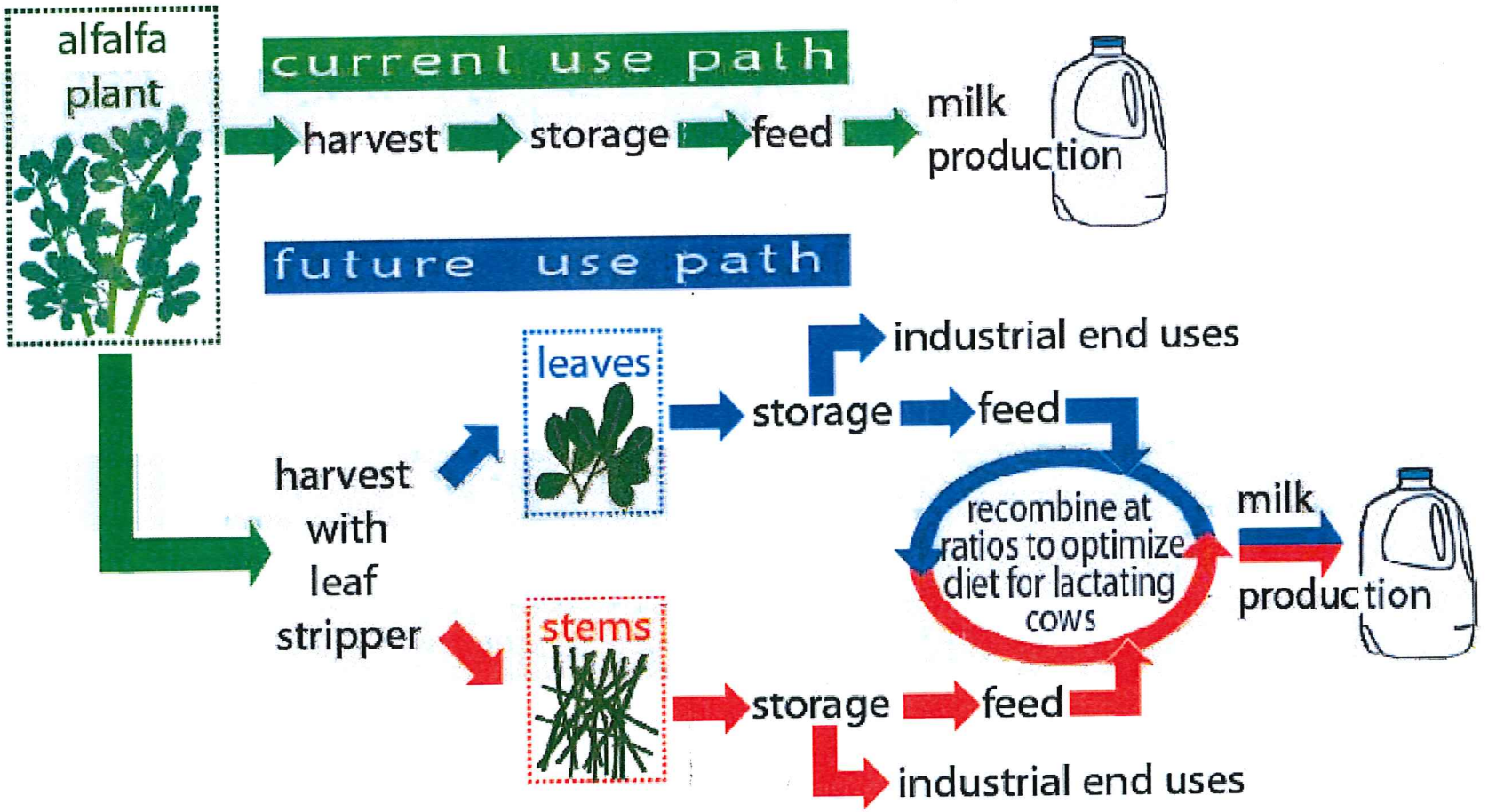
Remaining Stems

- **Stem Fraction: 40%***
- **Purity: 90% stems**
- **Protein: 13%**
- **Fiber: 50%**

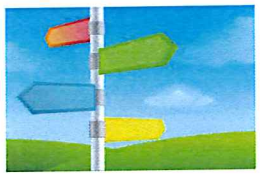
Harvest for maximum yield.
Forage quality not linked to harvest timing.

Shinners and Digman

Expand Alfalfa Product Options



Road Map Research



Expand Alfalfa Product Options

- Leaves
  - Develop for dairy
  - Develop as an alternative to soybean meal
  - Develop for value-added products
- Stems
  - Develop for dairy
  - Develop as an industrial feedstock

Route C: Quantifying Environmental Benefits of Alfalfa

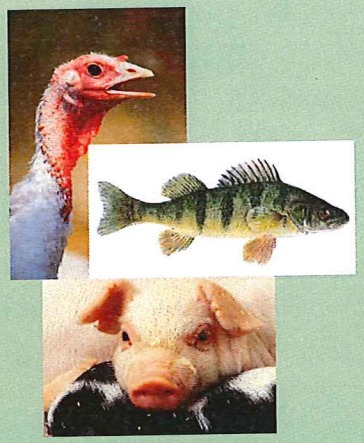
Objective: Develop and evaluate faming systems that strategically incorporate alfalfa on the landscape to reduce impacts of row crops and livestock

- Rotation effect (Samac, St. Paul)
  - Grain yield increases 5-15% after alfalfa
- Intercropping, living mulches (Grabber, Madison; Baker, St. Paul)
- Greenhouse gas reduction (Baker, St. Paul)
- Water quality improvement (Baker, Russelle, St. Paul)

The USDA-ARS Alfalfa Road Map

Develop Alfalfa for 21st Century Markets

Increase on-farm profits



Expand alfalfa product options

Increase dairy cattle utilization

Reduce the environmental impact of row crop agriculture

Thank You!

Questions?