Forage Breeding into the Future

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"Genetic modification of crops is not some kind of witchcraft; rather, it is the progressive harnessing of the forces of nature to the benefit of feeding the human race."

Dr. Norman Borlaug, Plant Breeder

- Father of the Green Revolution
- Winner of the Nobel Peace Prize 1970
- Congressional Gold Medal 2007
- Presidential Medal of Freedom 1977



North American Alfalfa Breeders

No alfalfa breeding at public institutions in U.S.

Alforex Seeds

- Forage Genetics International
- S & W Seed Company

Legacy Seed



Genetic modification of plants and animals

- Genetic modification of plants and animals has occurred throughout history
 - e.g. teosinte to corn, ryegrass types, breeds of cattle, horses, dogs, cats
- New breeding techniques being developed
 - Genomics to know where gene located and proximity to other genes
 - Use of marker genes in breeding



Application of Genomics in Grazing Management: A Pilot Survey of Wisconsin Grazing Herds

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Field Survey Design

- 28 Wisconsin grazing operations
- Each identified 2 good grazing cows and 2 poor grazing cows in herd.
- Cows were identified by the producer.
- Hair follicle samples taken from each cow
- **Coetis (Clarifide) for DNA testing and genomic proofs.**
- 112 grazing cows tested.
- 2012 projected DHIA 305 d milk, fat and protein yields recorded.



Relationships between milk yield and GPTA for milk in producer selected good and poor grazing cows.



305 Milk Yield , lbs/lactation

Marker assisted selection

indirect selection process where a <u>trait</u> of interest is selected based on a <u>marker</u> linked to a trait of interest (e.g. productivity, disease resistance, abiotic stress tolerance, and quality), rather than on the trait itself.



Trait of interest

Marker gene



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 - Genomics to know where gene located and proximity to other genes
 - Use of marker genes in breeding
 - Modification and addition of new genetic material





"You can't solve tomorrow's problems with yesterday's technology"

<u>New alfalfa GE-traits in development</u> Dairy manure management – reduced lignin Dairy nutrient management – tannin alfalfa Water quality – salt tolerance Water availability – water use efficiency Energy security – reduced lignin, etc.



Pollen flow does not change the genetics of the parent plant



For example, If a Holstein cow is bred by an Angus Bull

The offspring is a cross – but the Holstein mother has not changed genetically

With alfalfa we are harvesting the mother plant - not the offspring as in grain crops.



U.S. Red Clover Breeding

Breeding for persistence Heathcliff Riday, USDA, Madison, WI Ken Quesenberry, Univ of Florida







North American Cool Season Forage Grass Breeders

- Annie Classens, AAFC Québec
- Yousef Papadopoulos, AAFC Kentville
- Surya Acharya, AAFC Lethbridge
- Bruce Coulman, Bill Biligetu, U. of S./AAFC Saskatoon
- Mike Casler, USDA, Madison, WI
- Ken Vogel, USDA, Lincoln, NE (switchgrass)
- Tim Phillips, Univ of Kentucky



Forage Grass Breeding Companies

- Barenbrug, Netherlands
- DLF Trifolium, Denmark
- Eurograss, Germany
- New Zealand Plant Breeding and Research Assn



Conservation/Hay/Silage

- Timothy & Smooth brome long-time standards for hay; many old hayfields still around; used for CRP, but not much seed sales otherwise.
- Orchardgrass often used in mixtures with alfalfa; sometimes mixed with other grasses.
- Reed canarygrass mostly "invaded" wetlands.
- Tall fescue some old KY-31 types and some new types; not very common.
- Ryegrasses both perennial and Italian types; mostly emergency forage.



Pasture for Dairy, Beef, or Sheep

- Reed canarygrass a few pastures planted to low-alkaloid types.
- Tall fescue soft-leaf types; endophyte is not needed for winter survival.
- Perennial ryegrass niche usage in protected areas; mostly in mixtures.
 - **Meadow fescue** close relative of TF; introduced from Europe; demand >>> supply.



Selecting Grasses

Orchardgrass and tall fescue

Want winterhardy types





Selecting Grasses

Orchardgrass and tall fescue

- Want winterhardy types
- Want late maturing types





Forage Grass Breeding

- Development of <u>meadow fescue</u> as a "new" pasture crop.
 - very popular before the discovery of tall fescue.
 When KY-31 was released in 1953, meadow fescue completely disappeared within 7 years.
- Development of <u>non-flowering orchardgrass</u> for grazing.
 - Most is undesirable for grazing due to early and profuse flowering.







Project Timelines

- 1963 First germplasm discovery (A.W. Hovin).
- 1993 to 2015 Three generations of tandem selection
 - Seed production and disease resistance in the Willamette Valley of Oregon (Reed Barker, USDA & Devesh Singh, Barenbrug USA)
 - Forage production and sparse flowering in Wisconsin
- 2006 to 2011 Proof of concept trials
- 2016 to 2017 "Put up or shut up time"





Infrequent-harvest Means

Cultivar	Heading Date	Panicle Density (Cut-1 Yield	Regr. Yield	Total Yield
	May	#/m ²	Mg/ha	Mg/ha	Mg/ha
Sparse #1	30	53	3.36	4.86	8.17
Sparse #2	29	56	3.38	4.66	7.99
Sparse #3	30	74	3.67	4.88	8.48
Benchmark	24	128	4.54	5.28	9.75
Albert	26	168	4.89	4.97	9.80
Icon	26	128	4.24	4.90	9.08
%					
Change	8	-57	-24	-5	-14
LSD(0.01)	1	13	0.26	0.36	0.41



Frequent-harvest Means

		Regrowth	
Cultivar	Cut-1 Yield	yield	Total Yield
	Mg/ha	Mg/ha	Mg/ha
Sparse #1	1.44	5.82	7.25
Sparse #2	1.35	5.74	7.09
Sparse #3	1.51	6.24	7.75
Benchmark	2.17	6.92	9.09
Albert	2.11	6.39	8.51
Icon	2.00	6.27	8.27
% Change	-32	-9	-15
LSD(0.01)	0.25	0.48	0.54



Forage Quality Traits

	СР	NDF	NDFD	IVDMD
	g/kg	g/kg	g/kg	g/kg
First harvest				
Normal	118	607	597	760
Sparse	130	593	616	777
% Change	10	-2	3	2
LSD(0.01)	6	8	13	11
Regrowth				
Normal	147	581	644	795
Sparse	152	585	635	788
% Change	4	1	-2	-1
LSD(0.01)	NS	NS	NS	NS



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Charles Opitz Farm: Remnant Oak Savanna in 1990

First documentation of meadow fescue since the 1950s DNA marker tests to identify the unknown species Collection and agronomic evaluations to follow







At least four introduction events are responsible for immigration of meadow fescue into the Upper Mississippi Driftless Region.

Meadow Fescue Endophyte

- Fungal endophyte that lives in stems, leaf sheaths, and seeds.
- Mutualistic relationship
 - Host plant provides water, nutrients, & structure
 - What does the endophyte do for the host?
- Sample of 31 farms: 82% infection rate!





Agronomic Performance of 'Hidden Valley' Meadow Fescue

Cultivar and Species	Wisconsin Forage Yield	New York Forage Yield	Wisc. in vitro NDFd	NY in vitro NDFd
	Mg/ha	Mg/ha	%	%
Orchardgrass	6.51	-	67.8	-
Tall Fescue	7.04	10.67	67.7	71.6
European MF	6.26	9.81	73.0	73.0
Hidden Valley MF	6.43	10.14	74.0	73.5
LSD(0.05)	0.12	0.35	0.8	1.0
HVMF (% Change)	-8%	-5%	+9%	+3%



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Meadow Fescue Cultivars

- Hidden Valley (2014) public release seed from the Opitz farm.
- Azov (2015) public release selections made from plant introductions collected on the Azov peninsula on the Black Sea.

"Unnamed" cultivar (2017) Barenbrug USA – selection based on seed production and rust resistance in Oregon, combined with high yield and rust resistance in Wisconsin.



Collaborator Acknowledgements

- Dan Undersander
- Geoffrey Brink
- Jerry Cherney
- Edzard van Santen
- Yousef Papadopoulos
- Reed Barker
- Richard Johnson
- Shabtai Bittman
- Russell Mathison
- Doo-Hong Min
- Joseph Robins
- Surya Acharya
- Stephen Bowley
- Bruce Coulman
- Raynald Drapeau

- Nancy Ehlke
- Marvin Hall
- Richard Leep
- Réal Michaud
- John Rowsell
- Glenn Shewmaker
- Chris Teutsch
- Devesh Singh
- Michael Humphreys
- Toshihiko Yamada
- Ken-ichi Tamura
- Nick Ellison
- Charles Opitz
- Randy Jackson
- David Duncan



Summary

Public forage breeding programs are being reduced

- Responsible for many novel traits
- Alfalfa, clover, and cool season grass breeding declining
- Public forage testing programs being reduced
- International companies providing much of forage grass seed



For Additional Information

fyi.uwex.edu/forage



UW Publications Learning Store learningstore.uwex.edu



