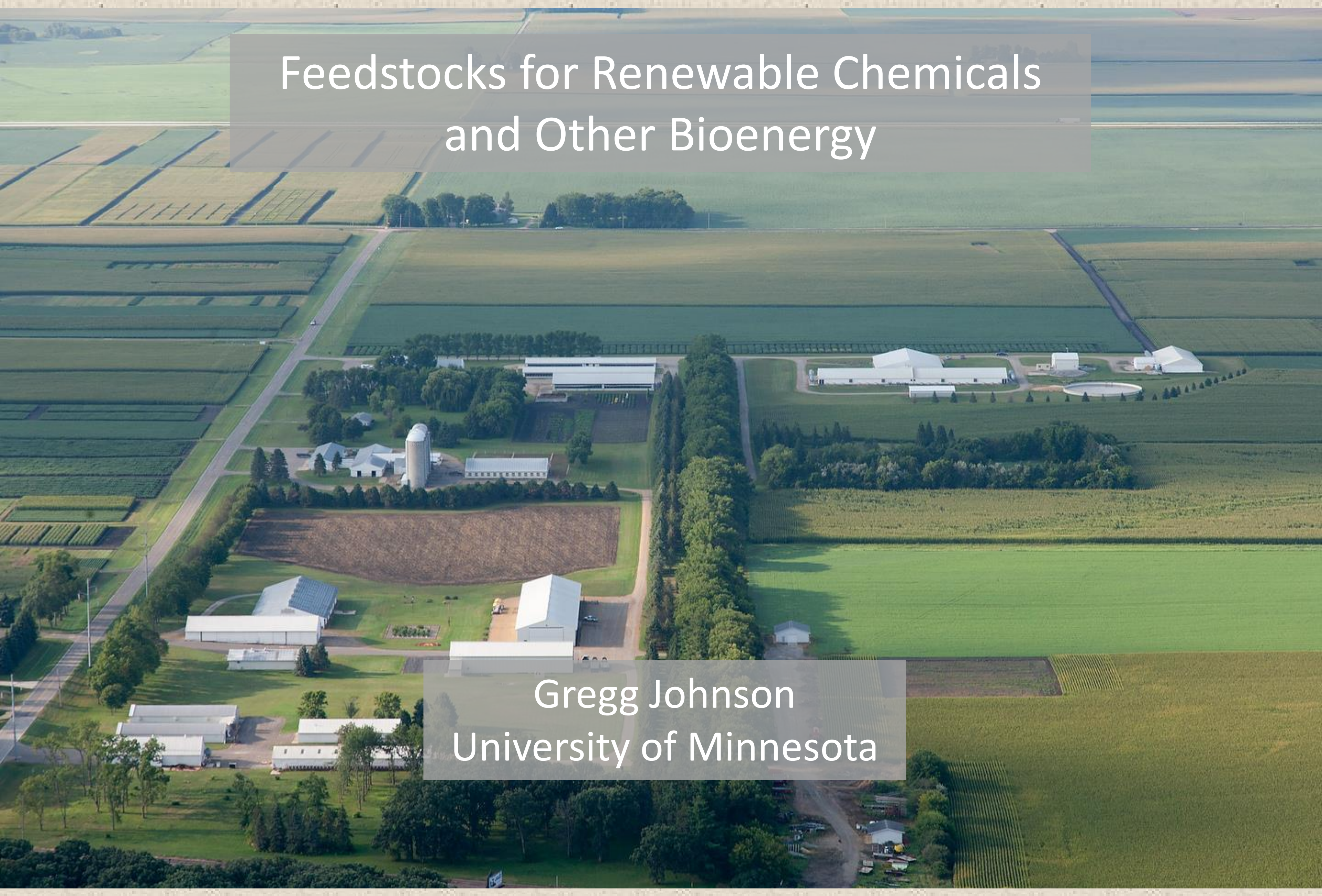
Feedstocks for Renewable Chemicals and Other Bioenergy



Gregg Johnson
University of Minnesota

Perennial Herbaceous Biomass Crops

Switchgrass

Prairie Cordgrass

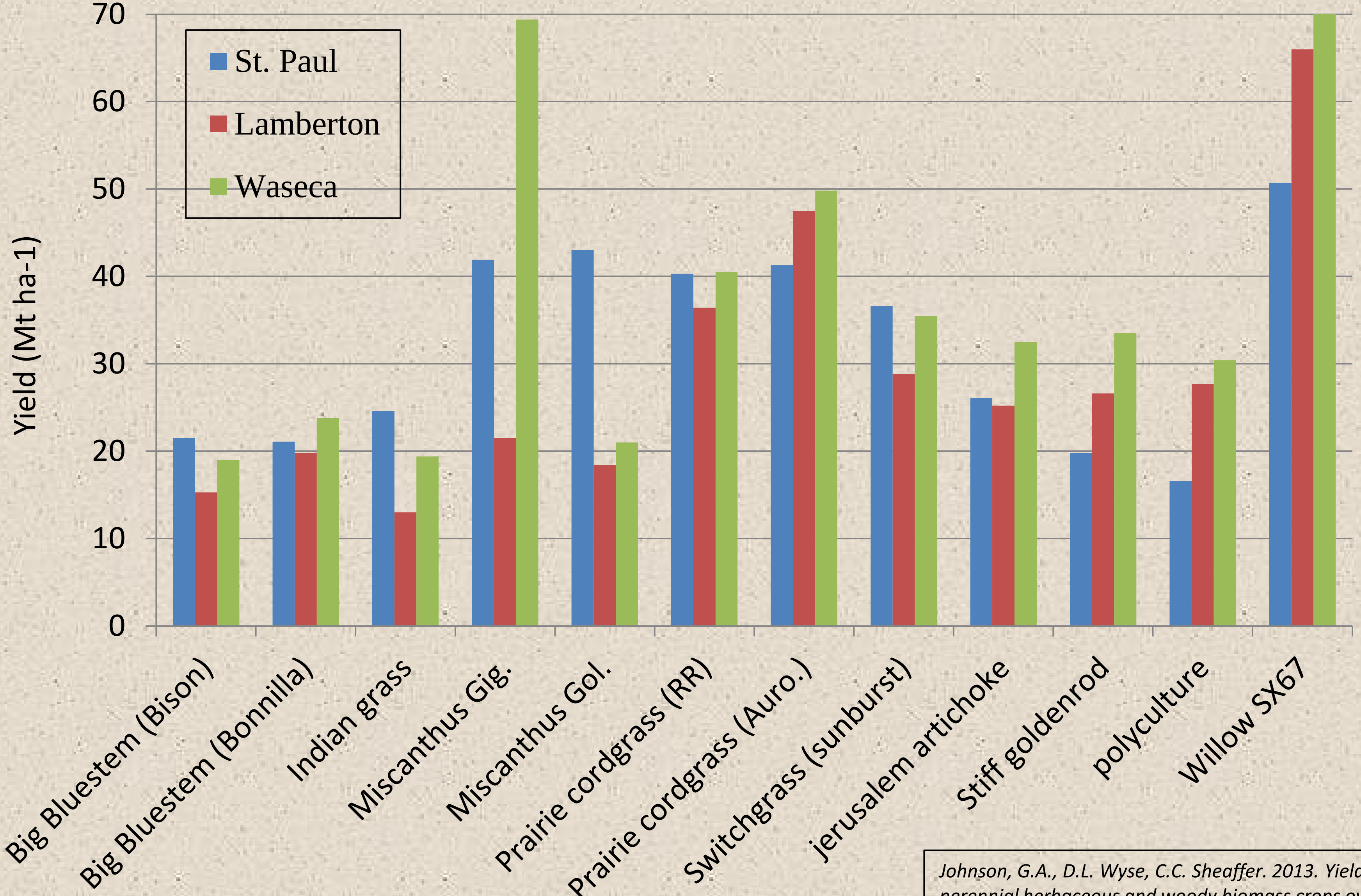
Polyculture

Cup plant

Miscanthus x giganteus

Big Bluestem

Total biomass production over a 4-year period



Johnson, G.A., D.L. Wyse, C.C. Sheaffer. 2013. Yield of perennial herbaceous and woody biomass crops over time across three locations. Biomass Bioenergy 58:267-274.

Oilseed Crops

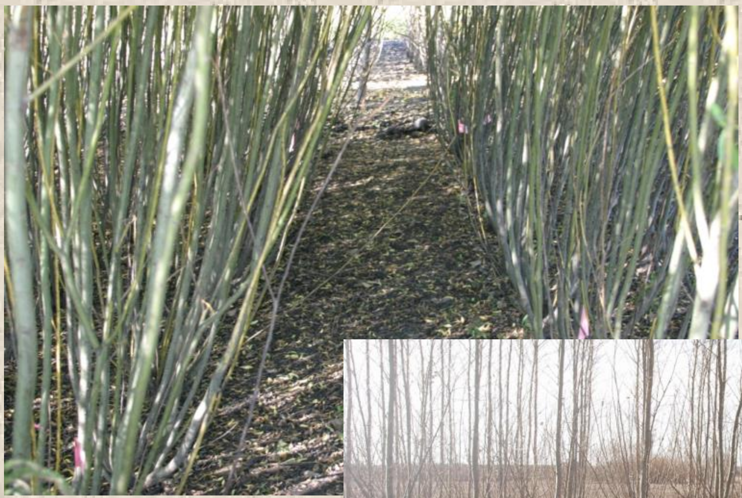
Field Pennycress, winter camelina, and soybean

Oilseed Crops

	Pennycress	Camelina	Soybean
Oil Content (%)	20-36	36-47	18-22
Pour Point (^oC)	-18	-4	-3
C16:0	3.1	6.8	10.5
C18:0	0.5	2.7	4.1
C18:2	22.4	19.6	53.6
C18:3	11.8	32.6	7.7
C20:1	8.6	12.4	T
C22:1	32.8	2.3	0

Adapted from: Moser, B.R., S.N. Shah, J.K. Winkler-Moser, S.F. Vaughn, and R.L. Evangelista. 2009. Composition and physical properties of cress and field pennycress oils. Industrial Crops and Products. 30(2): 199-205

Woody Biomass Crops



Average willow biomass yield per year after 3 harvest cycles in Waseca, MN

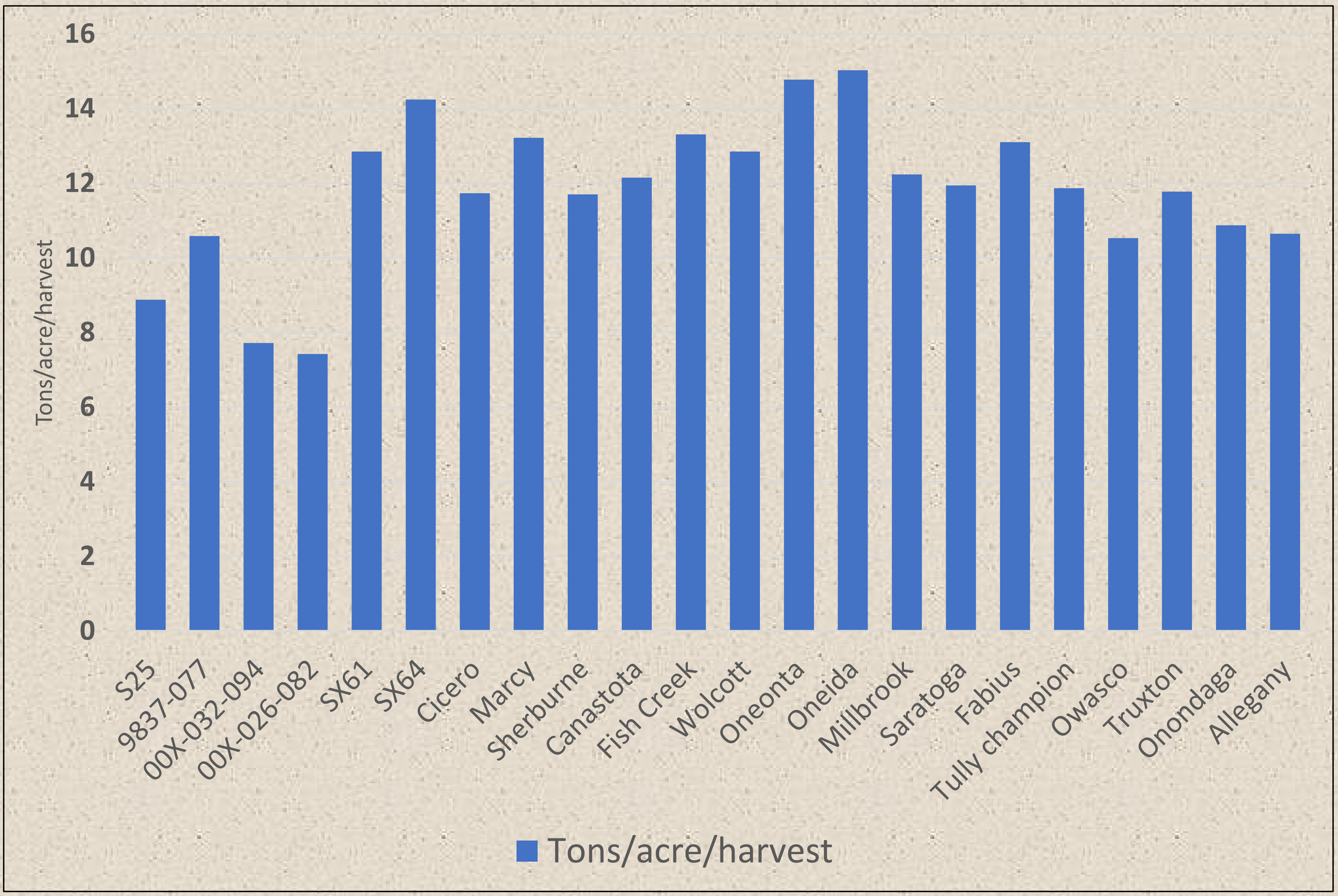
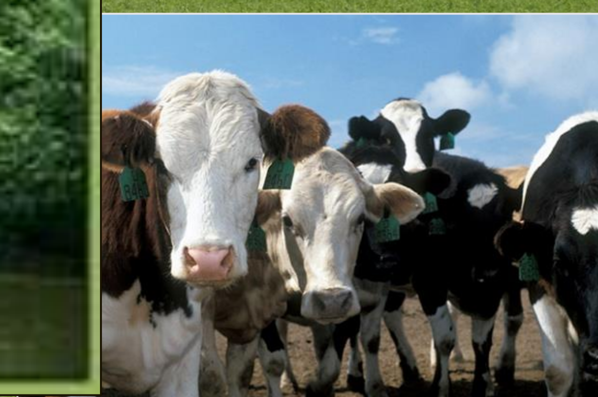


Table 5. Yield and rank of willow cultivars in Waseca, MN for three three-year harvests and total yield. The top five willow cultivars are highlighted.

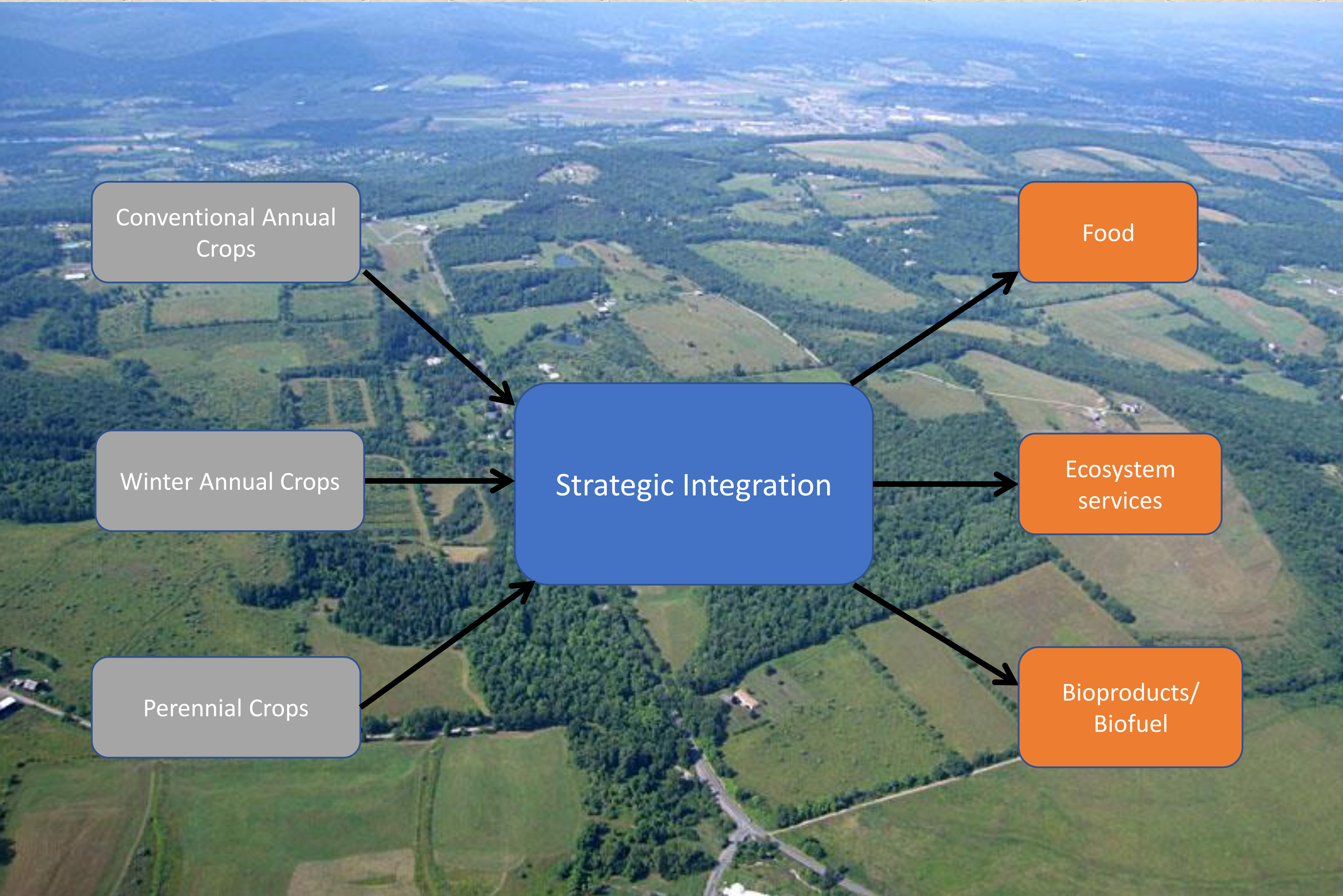
Cultivar	Yield after 1st harvest (Mg ha^{-1})	Rank	Yield after 2nd harvest (Mg ha^{-1})	Rank	Yield after 3rd harvest (Mg ha^{-1})	Rank	Total yield after three harvests (Mg ha^{-1})	Rank
SX64	30.4	1	34.9	5	30.6	4	95.8	3
Fabius	30.0	2	30.3	10	27.7	6	88.1	6
Oneida	29.4	3	37.1	1	34.5	2	101.1	1
SX61	28.8	4	34.9	4	22.6	15	86.4	8
Marcy	28.7	5	35.1	3	25.0	9	88.9	5
Oneonta	28.7	6	36.1	2	34.6	1	99.4	2
Millbrook	27.3	7	30.7	9	24.3	11	82.3	9
Fish Creek	27.2	8	32.6	6	29.7	5	89.5	4
Canastota	26.9	9	31.4	8	23.4	12	81.7	10
Wolcott	26.9	10	28.8	14	30.7	3	86.4	7
Truxton	26.9	11	29.6	13	22.8	14	79.2	13
Cicero	26.8	12	29.9	12	22.2	16	78.9	14
Saratoga	26.6	13	27.1	16	26.5	7	80.3	11
Owasco	26.5	14	24.8	20	19.4	21	70.8	20
9832-49	26.4	15	25.7	19	18.8	22	70.9	19
Sherburne	25.8	16	30.0	11	22.8	13	78.7	15
Otisco	25.5	17	20.4	21	20.1	19	66.0	21
9837-77	23.9	18	27.1	17	20.2	18	71.2	18
Tully Champion	22.7	19	31.4	7	25.6	8	79.8	12
Allegany	22.5	20	28.5	15	20.5	17	71.6	17
Onondaga	22.0	21	26.4	18	24.7	10	73.1	16
00X-032-094	20.8	22	18.2	24	12.9	23	51.9	23
00X-026-082	20.3	23	19.3	23	10.4	24	49.9	24
S25	19.8	24	20.3	22	19.6	20	59.7	22

Johnson, G.A., T.A. Volk,, K. Hallen, S. Shi, M. Bickell, and J. Heavey. 2018. Shrub willow biomass production ranking across three harvests in New York and Minnesota. Bio. Res.

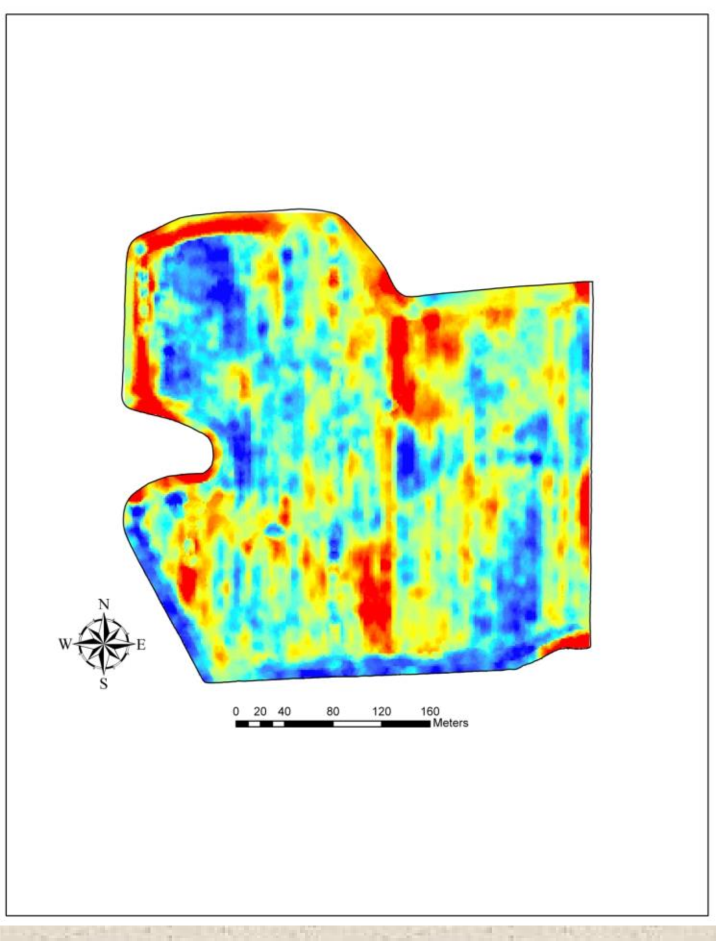
Landscape Design

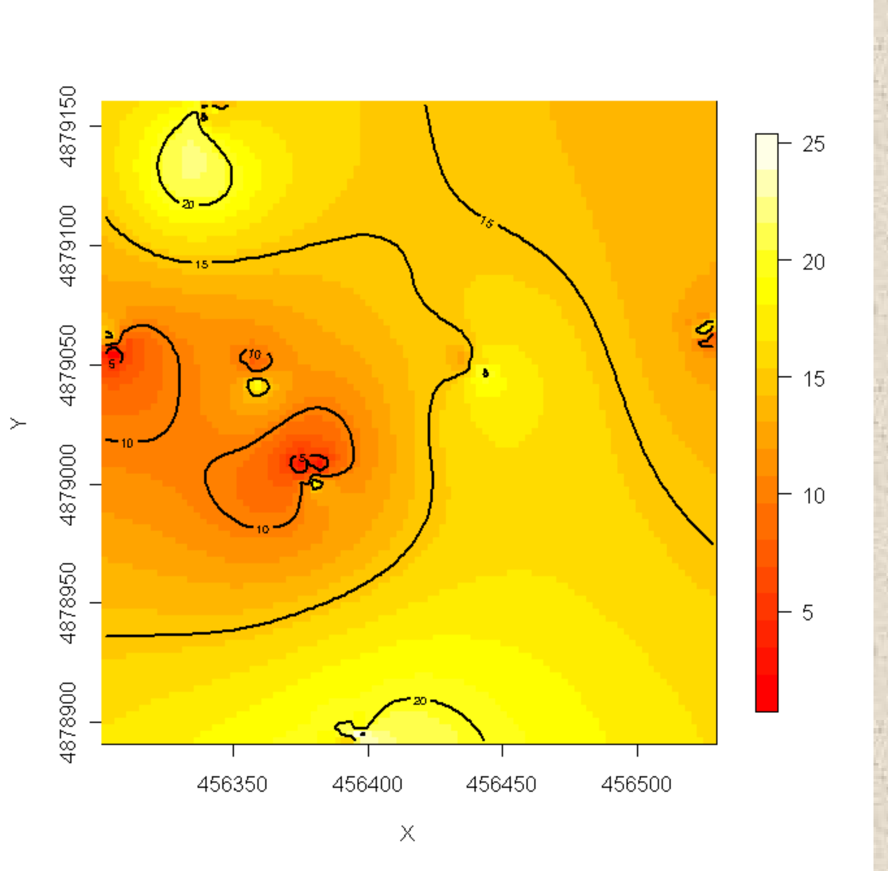


- How can agricultural systems be organized around multiple values, e.g. the production of food, bioproducts, and ecosystem services?



✓ Corn's sensitivity to changing landscape position presents opportunities to increase overall landscape productivity by integrating other crops into the landscape.





Productivity Matrix for Biomass Crops

	Summit	Depositional	Flat	W hillslope	S hillslope	SW hillslope	N hillslope
Switchgrass	+	-	-	+	-	-	-
Alfalfa	+	-	+	-	+	+	+
Corn Stover	+	-	-	+	+	+	+
Corn Grain	+	-	-	+	+	-	+
Willow SX67	-	+	+		-	+	-
Willow 9882	-	+	+	-	-	-	-
Cottwd.D125	+	+	+	+	+	+	+
Poplar NM6	+	-	+	+	+	+	+

Thelemann*, R., G.A. Johnson, C. Sheaffer, S. Banerjee, H. Cai, and D. Wyse. 2010. The effect of landscape position on biomass crop yield. Agron. J. 102:513-522.

CI=90%

Spatial Intensification

Resource availability
Plant diversity
Structural diversity
Harvest timing

SunGrant INITIATIVE
NORTH CENTRAL CENTER
South Dakota State University

✓ Combine the benefits of bio-feedstock production with tangible ecosystem services in a way that provides greater value.

USDA United States Department of Agriculture National Institute of Food and Agriculture

Photo Credit: P. Bryant, M. Rice, T. Murray, J. Eckberg

Temporal Intensification

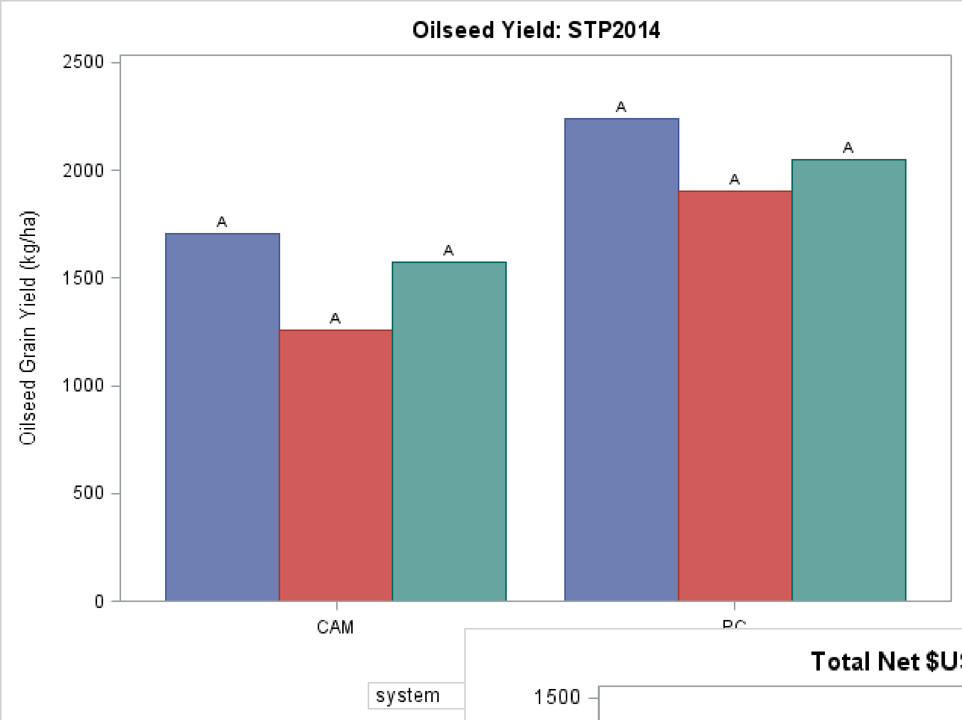
Field pennycress or camelina planted into corn, sweet corn, dry beans, sugar beets, etc.

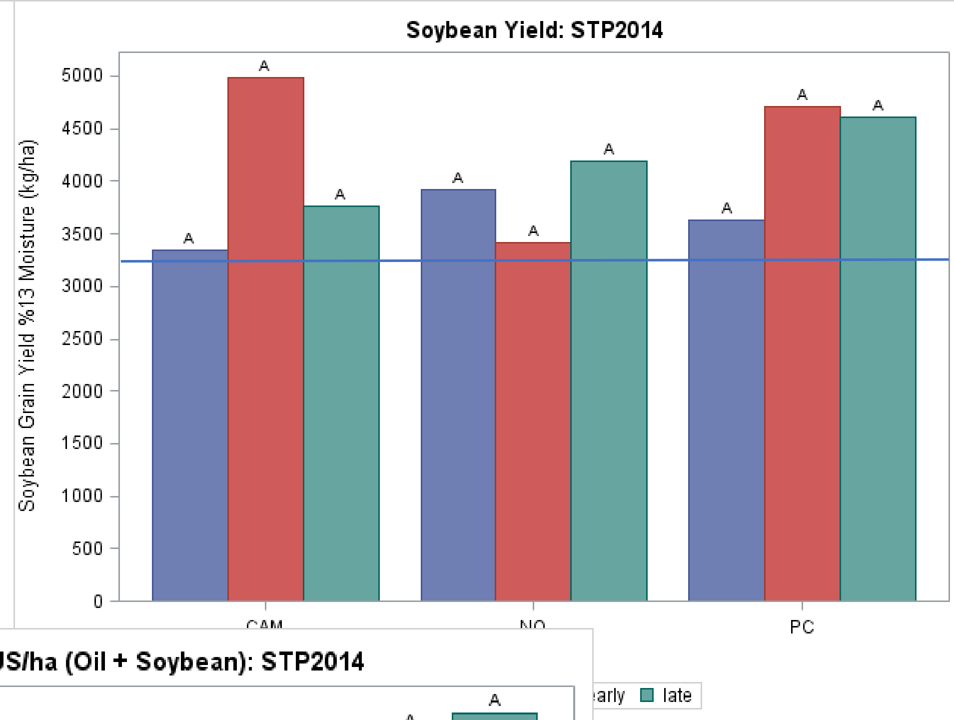
Pennycress seeded into corn

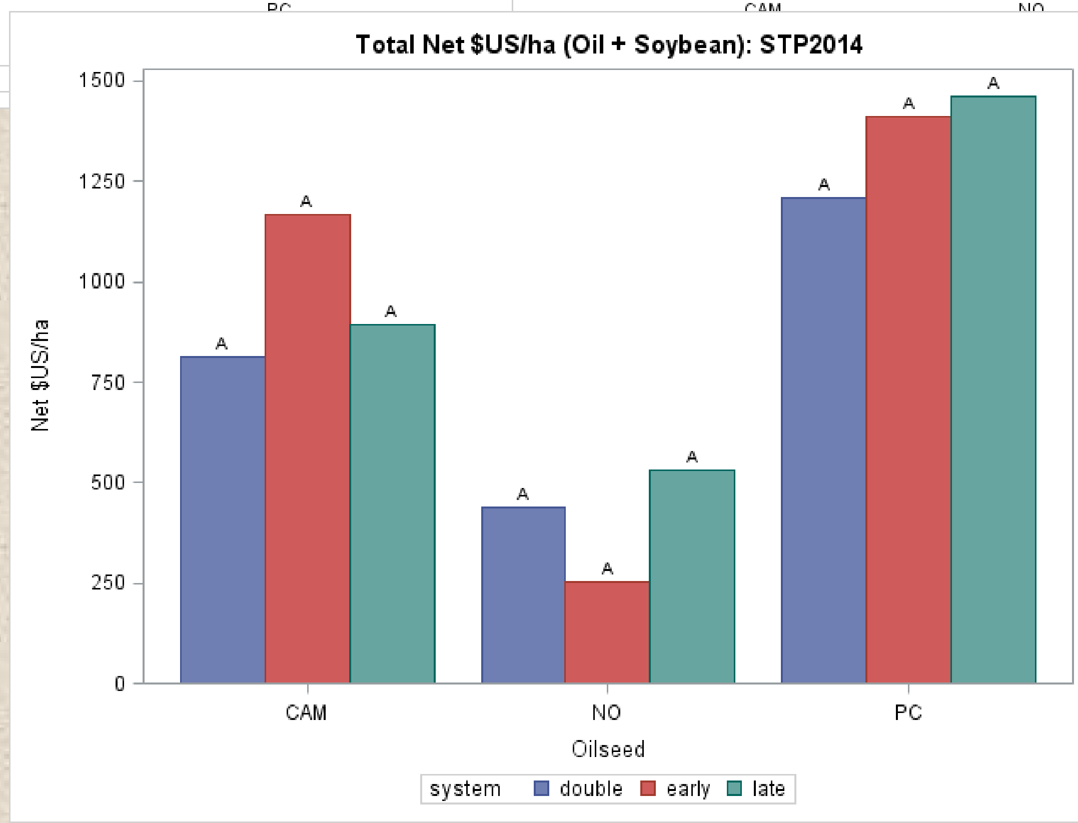
Pennycress mid- May

Relay cropping

Double-cropping





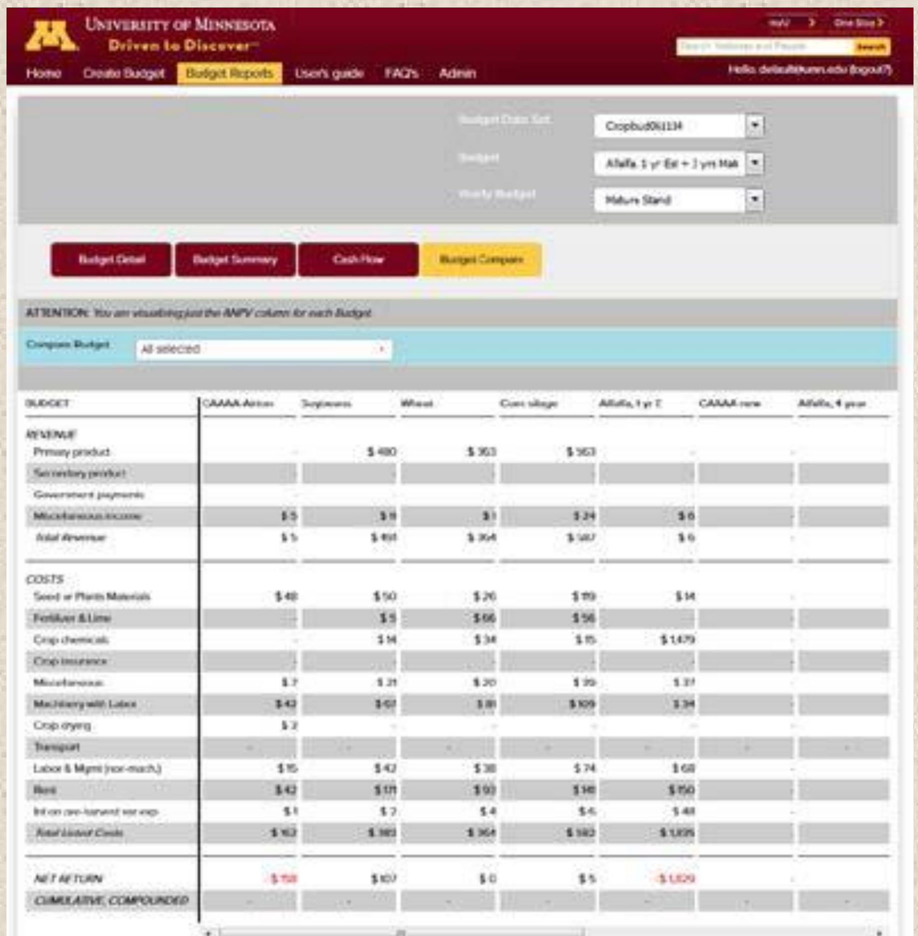


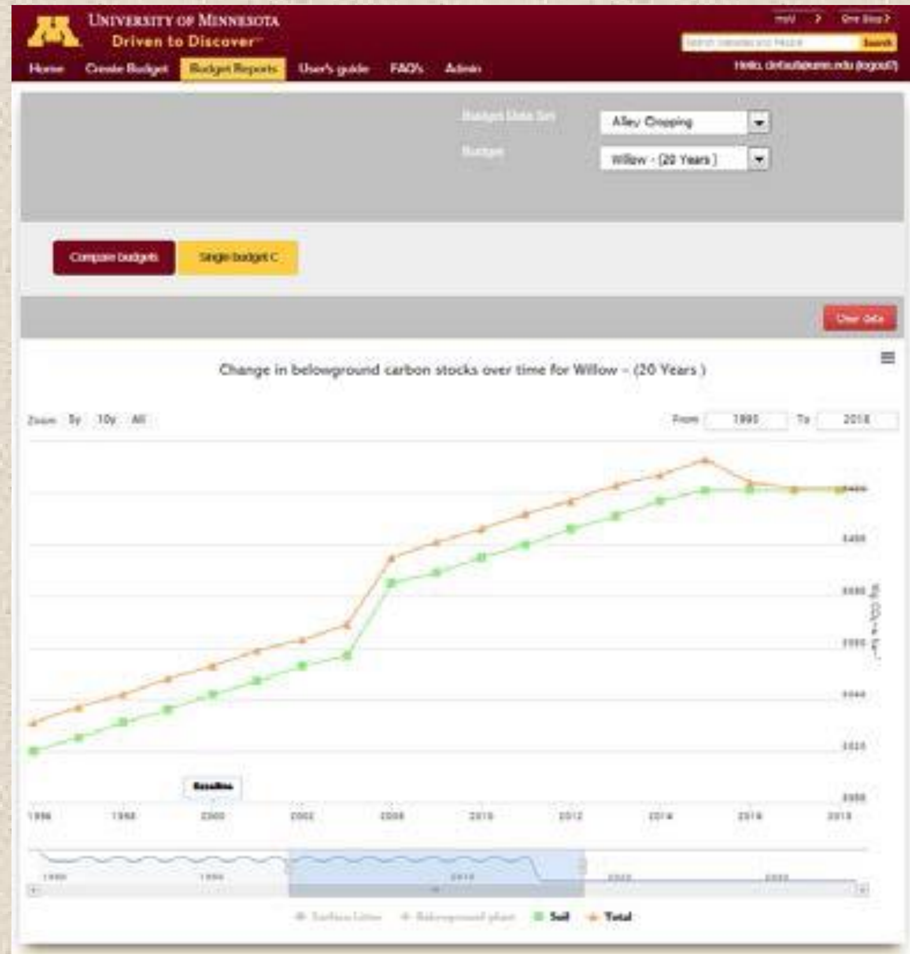
Slides courtesy of Dr. Scott Wells

Crop Enterprise and Environmental Budgeting Tool (CE^2T)

- ✓ Designed to estimate the breakeven price needed to cover the costs of producing biomass/grain from conventional and alternative feedstocks as well as provide environmental information for broader decision-making.

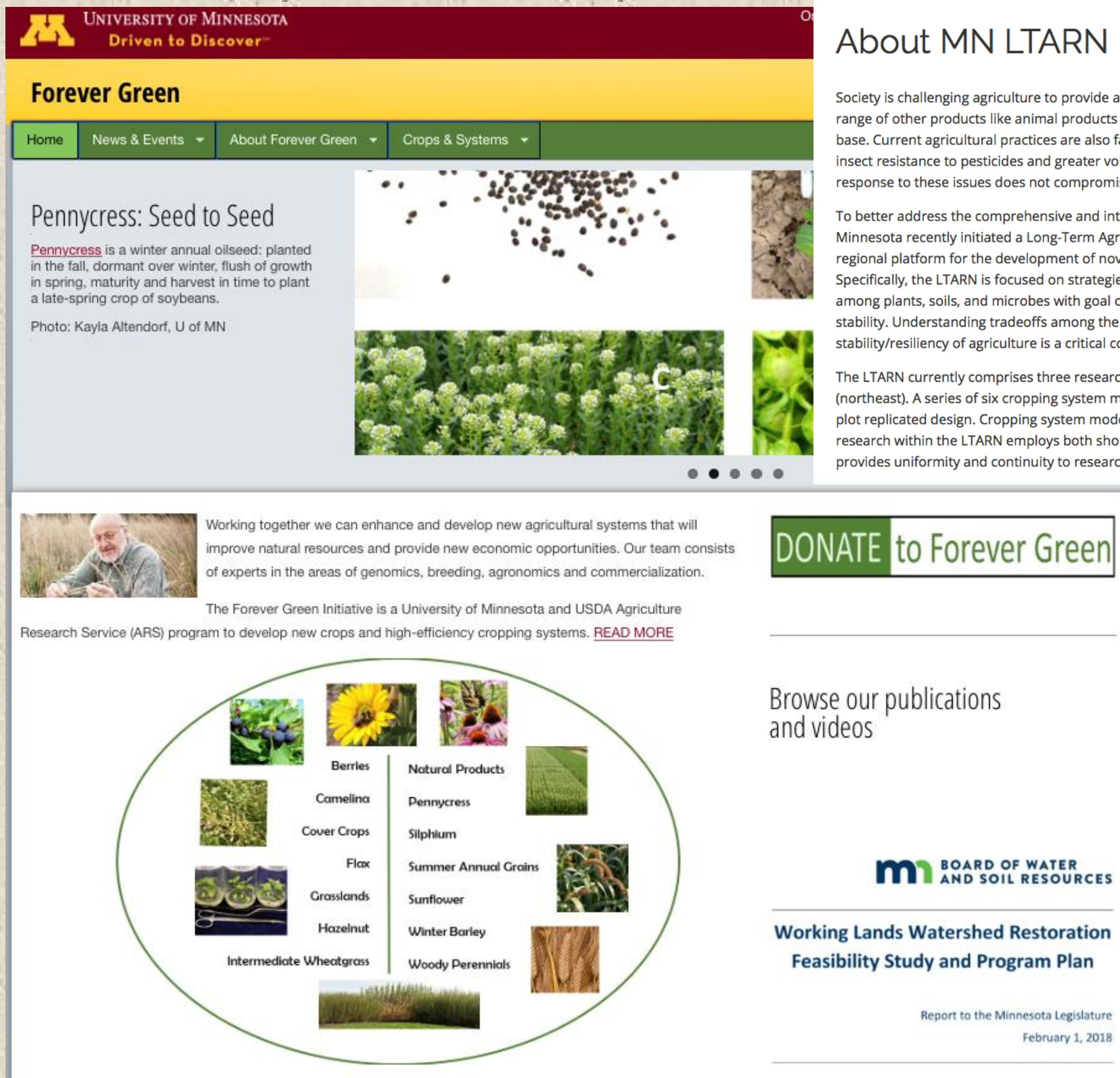
- ✓ Reports are generated comparing the economics and environmental benefits between your current management practices and future scenarios.





Forever Green Initiative

www.forevergreeen.umn.edu



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