

Project/ Activity Number:NE1010

Project/Activity Title: Breeding and Genetics of Forage Crops to Improve Productivity, Quality, and Industrial Uses.

Period Covered: October 2007 to September 2008

Date of this Report:

Annual Meeting Dates: 08/07/2008 to08/08/2008

Participants:

Acharya, Surya	acharya@agr.gc.ca ; AAFC, Lethbridge, AB, Canada
Brummer, Charlie	brummer@uga.edu ; University of Georgia
Coulman, Bruce	bruce.coulman@usask.ca ; University of Saskatchewan, Canada
Ehlke, Nancy	nancy@umn.edu ; University of Minnesota
Hopkins, Andy	aahopkins@noble.org ; Noble Foundation
Lamb, JoAnn	JoAnn.Lamb@ars.usda.gov ; USDA-ARS, PSRU, Saint Paul, MN
Michaud, Real	michaudr@agr.gc.ca ; AAFC, Ste-Foy, QC, Canada
Papadopoulos, Yousef	papadopoulosy@agr.gc.ca ; AAFC, Charlottetown, PEI, Canada
Peel, Michael	Mike.Peel@ars.usda.gov ; USDA-ARS, FRRL, Logan, UT
Robins, Joe	Joseph.Robins@ars.usda.gov ; USDA-ARS, FRRL, Logan UT
Viands, Don	drv3@cornell.edu ; Cornell University

Abbreviations:

AFCCCH	Agriculture and Agri-Food Canada, Charlottetown, NS
AFCL	Agriculture and Agri-Food Canada, Lethbridge, AB
AFCSF	Agriculture and Agri-Food Canada, Ste. Foy, QC
AFCSK	Agriculture and Agri-Food Canada, Saskatoon, SK
FRRL	USDA-ARS Forage and Range Research Lab, Logan, UT
GA	University of Georgia, Athens, GA
IA	Iowa State University, Ames, IA
KY	University of Kentucky, Lexington, KY
MN	University of Minnesota, Saint Paul, MN
NGPRL	USDA-ARS, Northern Great Plains Research Lab, Mandan, ND
NY	Cornell University, Ithaca, NY
PSRUMN	USDA-ARS, Plant Science Research Unit, St. Paul, MN
PSWMRL	USDA-ARS, Pasture Systems & Watershed Management Research Lab, PA
SD	South Dakota State University, Brookings, SD
USDFRC	US Dairy Forage Research Center, Madison, WI

Brief Summary of Minutes of Annual Meeting:

Held at Agriculture and Agri-Food Canada, Lethbridge, AB, 08/07/2008

The group was welcomed by Jeff Stewart, Science Director for crop breeding and genetics programs in Agriculture and Agri-Food Canada.

The group welcomed Joe Robins of FRRL and Andy Hopkins of the Noble Foundation to the meeting.

Objective 1: Evaluate new plant characters and develop germplasm and cultivars with these characters to improve perennial forage species as livestock feed and biofuel uses to enhance rural vitality and promote more secure energy sources.

1.1 Alfalfa

1.1.1 Identification of traits useful for improving *M. sativa* ssp. *falcata* germplasm.

Lead: Brummer, GA. Cooperating locations: AFCSF, NGPRL, SD, FRRL.

Data have been collected and C. Brummer will analyze the data and write the manuscript.

1.1.2 Genetics and improvement of naturalized alfalfa (*M. sativa* subsp. *falcata*).

Lead: Boe, SD. Cooperating locations: GA, FRRL.

Data were collected and a manuscript is under preparation. Ivan Mott at FRRL has completed a molecular diversity study of this plant material and a manuscript on this molecular data has been initiated.

1.1.3 Breeding for resistance to alfalfa snout beetle in alfalfa.

Lead: Viands, NY. Cooperating locations: other alfalfa researchers.

This pest is spreading throughout NY. Five to six selection cycles have now been completed in several alfalfa populations under field conditions. Resistant populations will be evaluated by the NE1010 collaborators.

1.1.4 Developing alfalfa germplasm with potato leafhopper resistance from three diverse genetic sources.

Lead: Viands, NY. Cooperating locations: IA (now GA), SD.

Many different mechanisms appear to be involved in PLH tolerance, not just glandular hairs. Second cycle of selection nearly completed. Viands will send seed to C. Brummer (GA) for fall establishment.

1.1.6 Acid and Aluminum tolerance in tetraploid alfalfa.

Lead: Acharya, AFCL. Cooperating locations: NY, AFCCH

Phase I of research is completed. Phase II will be established next year (2009). Seed from all three locations will be shared and used for spaced plants in half sib progeny. The three scientists involved will speak separately and plan Phase II of the study. Soils will be tested for both acidity and aluminum. Oklahoma State U. can test for aluminum.

C. Brummer is mapping QTLs for aluminum tolerance in collaboration with Maria Monteros at Noble Foundation. Brummer will discuss with Maria whether this project will become a sub-objective in NE1010.

1.2 Birdsfoot trefoil

1.2.1 Rhizomatous birdsfoot trefoil for yield improvement.

Lead: Riday, USDFRC. Cooperating locations: NY, SD, AFCCH.

Fourth cycle of selection is currently at NY. Plant vigor not great but will be backcrossed to 'Pardee'. Ehlke will evaluate when needed.

1.2.2 Single-row plot evaluation of birdsfoot trefoil for vigor.

Lead: Peel, FRRL. Cooperating locations: MN, NY, AFCCH, USDFRL.

Research is scheduled to begin in 2009. Seed from all locations should be sent to Peel (40 g) by April 1st 2009 and he will package. Single row trial will be scored for seedling vigor, and assessed for dry matter yield.

1.3 Reed canarygrass (NARC): Collection and evaluation of naturalized reed canarygrass populations for biofuel and forage traits.

Lead: Casler, USDFRC. Cooperating locations: IA (now GA), NY.

Data collection has been completed and data analysis is underway.

1.5 Multiple species

1.5.1 Selection of fiber digestibility and cell wall pectin.

Lead: Viands, NY. Cooperating locations: AFCSF, WI.

Viands reported that selection for ratios of quality components has not worked as well as selection for individual quality components in alfalfa. Michaud reported that selection for nonstructural carbohydrates (NSC) was impacted by the time of cutting (morning or afternoon) in alfalfa. New selection nurseries were established in NY in 2008. NY has released its first alfalfa cultivar that was bred for higher concentration of pectin.

1.5.2 Grass-grass and grass-forb mixtures for long-term sustainable biomass production.

CoLeads: Ehlke, MN and Boe, SD. Cooperating locations: other researchers MN, ND.

Several combinations of native forbs, grasses and legume polycultures are being compared for biomass/bioenergy production. This study was initiated in 2007 and biomass from these plots will be harvested each year through 2016.

1.6 Red Clover:

To be developed: Marker-assisted selection.

Lead: Riday, USDFRL. Cooperating locations: AFCNS, GA and European researchers.

Half sib seed production is underway. Germplasm has been sent to Japan for genotyping and the three cooperating locations will have evaluation trials.

1.7 White Clover:

To be developed: Marker-assisted selection.

Lead: Brummer, GA. Cooperating locations: USDFRC and NOBLE Foundation.

Seed produced in New Zealand: half sib seed - 16 genotypes from 24 cultivars. Drought tolerance will be main research thrust. Currently there are no dedicated monies.

1.8 Kura Clover:

To be developed: Vigor and spreadability.

Lead: Ehlke, MN. Cooperating locations: USDFRL, AFCCH, FRRL.

Plans delayed until 2009- Riday, Ehlke, Papadopoulos, and Peel.

Group will discuss next meeting

Objective 2: Build on previous research to evaluate additional breeding methods for improving yield and persistence of alfalfa, red clover, orchardgrass, and other forage species to make production agriculture more economical and sustainable.

2.1 Alfalfa

2.1.1 Comparison of mass, S₁, and S₂ selection in alfalfa.

Lead: Michaud, AFCSF. Cooperating locations: AFCSK, AFCL, PSRUMN, NY.
Last harvests will be taken in 2009.

2.1.2 Replicated clonal selection for improving forage yield of alfalfa.

Lead: Viands, NY. Cooperating locations: AFCSF, GA, AFCL.
One cycle of selection completed and evaluated. Seed will be intercrossed in winter 2008/2009. Viands will send cuttings to cooperators by January 2009. Brummer doing some marker work with this material. For the second cycle of selection we may do some selection using markers only.

2.2 Orchardgrass:

2.2.1 Clonal selection in orchardgrass for broad adaptation.

Lead: Phillips, KY. Cooperating locations: GA, AFCL, AFCSF, AFCSK, SD.
No report. This project has never gotten off the ground - Curious as to the status of Phillips. Viands will try to contact Phillips. Hopkins mentioned that he has tested a number of Moroccan orchardgrass accessions, but they were not winterhardy.

2.2.2 Non-heading orchardgrass research.

Lead: Casler, USDFRL. Cooperating locations: AFCNS, AFCL, AFCSF, AFCSK, FRRL, ID, MN, KY, WV, NY, Newfoundland.
Plots were established in 2007 and harvests began in 2008. Quality data are being collected at some locations but not all.

2.3 Red clover:

2.3.1 Selection for general adaptation in red clover.

Lead: Papadopoulos, AFCCH. Cooperating locations: NY, AFCL, AFCSF, AFCSK, SD, USDFRC.

Phase II of the research is completed. Selection was conducted at seven locations and eight populations were planted for seed increase. Diallel population crosses will be made. It will take two to three years before enough seed will be available for evaluation trials.

2.3.2 Selection for persistence in red clover using half-sib families.

Lead: Riday, USDFRC. Cooperating locations: IA (now GA), SD, AFCCH.
All locations have finished selections.

2.4 RENEW Legume/Grass mixtures: Compatibility of legumes with various grasses.

Originally trefoil and orchard grass. Brummer stated that Riday has the seed and the original project is likely on the back burner. Peel has trefoil and tall fescue mixtures - with and without grazing.

NEW Co Leads: Peel, and Robins at FRRL. Volunteered cooperating locations: USDFRC, AFCNS, GA, MN, NY, PSRUMN AFCCH, AFCL.

Project could include: breeding methodology for mixtures, focusing on red clover, trefoil, sainfoin, and selection of lines in mixtures with grasses or other legumes. The new group will decide on protocol and use species appropriate to each region in 2009 with starting projects in 2010/2011.

2.5 NEW Red Clover for Biofuels:

To be developed: Lead: Papadopoulos.

Small project started but not funded. Looking at N₂ fixation inputs and lower ash production. This project will be discussed in 2009.

2.6 NEW Reed Canarygrass – Methods to improve forage yield

Lead: Casler, USDFRC. Volunteered cooperators: AFCCH, AFCSF, AFCSK, GA, NY, SD.

Create half sib families and compare methods of breeding for yield.

Objective 3: Evaluate new experimental populations and cultivars of perennial forage species for characteristics necessary for breeders, seed companies, seed and forage producers, and crop consultants to make decisions on commercial use over large regions.

3.1 Alfalfa

3.1.1 Evaluation of new *M. sativa* subsp. *falcata* populations.

Lead: Riday, USDFRC. Cooperating locations: AFCSF, AFCL, NGPRL, SD, FRRL, AFCSK, GA, NY.

Data have been collected. Peel would like to have the data. Peel suggested a new trial in 2-3 years with different lines. This will be discussed in 2009.

3.1.2 Hybrid alfalfa yield evaluation.

Lead: Riday, USDFRC Cooperating locations: NY, SD, IA, PSRUMN.

Population hybrids (collaboration with Dairyland) - established in 2006 - evaluated in 07-08.

3.1.3. Salt tolerance in alfalfa- (new – To be developed)

Lead: Acharya AFCL Cooperating locations: FRRL.

Will discuss in 2009 and start 2010/2011.

3.3 Multiple species

3.3.1 Biomass Alfalfa/Grass mixture evaluation.

Lead: Lamb USDA-ARS, Cooperating locations SD, USDFRC.

Compare monocultures and mixtures of two experimental biomass alfalfas, reed canarygrass, intermediate wheatgrass, and smooth brome grass for biomass yield and quality. Plots were established in 2008.

3.3.2 NEW Evaluation of cultivars and germplasms under grazing.

Co Leads: Riday and Casler, USDFRC.

Neither of the leaders attended annual meeting. Discussion of this project will be in 2009 with seeding proposed for 2010.

3.4 Meadow and hybrid bromegrass: Evaluation of meadow and hybrid bromegrass

Lead: Coulman, AFCSK. Cooperating locations: AFCSF, AFCCH, SD, USDFRC.

Selected populations are currently under seed increase and seed will be distributed to the collaborators in time for establishment of new evaluation nurseries in 2009.

3.5 Red clover evaluation:

3.5.1 Lead: Papadopoulos, AFCCH. Cooperating locations: AFCSF (plowed), AFCSK, AFCL, NY, USDFRC, SD.

Please record stand data in fall 2008. For those that still have the plots, 2008 will be the final year of data collection. Papadopoulos will send information to collaborators as to whether to send seed or plants for next round of selection. Peel would like to be included in next round of selection.

3.5.2 Red Clover Yield Stability:

Lead: Riday. Cooperating locations: NY, others.

Replicated rows of 10 entries selected for forage yield stability, 10 non-selected entires, and 5 control entries were established in 2008. Yield will be measured in multiple harvests in the next two years to determine yield stability at various locations.

3.6 Tall Fescue

3.6.1 NEW Tall Fescue -Selection for persistence in the Southern Coastal plains

Lead: Brummer, GA. Cooperating locations: Noble Foundation, KY, FRRL.

Brummer made selections from GA, Noble and KY lines under drought conditions in Tifton, GA. These populations will be evaluated.

NEED TO GET TEMPLATE FROM DON VIANDS FOR ALL LEAD SCIENTISTS TO PREPARE A DESCRIPTION PAGE OR PARAGRAPH FOR EACH PROJECT FOR POSTING ON THE WEBSITE

NEXT MEETING: June 18-19, 2009 at the University of Minnesota, Saint Paul Campus.

Hosts: Nancy Ehlke and JoAnn Lamb

Chair: Surya Acharya

Secretary: Joe Robins

2010 Annual Meeting will be in Atlanta or Athens, GA, hosted by Charlie Brummer.

The business meeting was followed by a field tour of the Lethbridge forage research program.

The group thanked Surya Acharya for his excellent hosting of this NE1010 meeting.

Accomplishments:

Objective 1: (1) Useful traits have been identified in *Medicago sativa* ssp. *falcata* and germplasms are currently under multi-location evaluation; (2) Snout beetle resistant alfalfas have been produced and are currently being evaluated; (3) Potato leaf hopper resistant alfalfa populations have been developed; and (4) alfalfa populations with increased pectin concentration have been created and a cultivar released.

Objective 2: (1) Selection methods for increased yield in alfalfa are currently under multiple site evaluation; (2) Red clover populations with improved persistence are currently under evaluation at multiple sites; (3) Selections for non-flowering orchardgrass are currently under evaluation at several locations in the U.S. and Canada.

Objective 3: (1) Selection of meadow and hybrid bromegrass are currently under seed increase and all populations will be established in 2009 at five locations; (2) improved red clover populations for general adaptation are currently being evaluated across the U.S. and Canada.

Impact Statements:

1. The potential impacts of the multistate research include, but are not limited to: enhanced livestock performance/health as well as economic advantages through the development of new cultivars of grasses and legumes with improved forage yield and quality characteristics and multiple pest resistance.
2. Contribute to improved environmental quality through the development of new cultivars of grass and legumes with improved persistence, increased resistance to abiotic and biotic stresses, and enhanced soil/binding improvement capabilities (e.g. reduced soil erosion; improved nutrient cycling; less surface water runoff; increased soil carbon sequestration; reduce atmospheric CO₂; reduced use of agricultural chemicals/fertilizers; reduced pollution/contamination of surface and ground waters).
3. Through the use of improved forages, increased diversification and sustainability in agricultural ecosystems should be achieved. The new cultivars of grasses and legumes will have multiple uses/attributes such as forage for livestock and biomass for renewable energy production.

Publications:

Hansen, J.L., H. Mayton, P. Salon, J. Crawford, C. Watkins, and D. R. Viands. 2008. Evaluation of perennial warm season grasses for use as bioenergy feedstock. NE Branch Amer. Soc. Agron. 13-16 July 2008. Montreal, Canada. *Plants and Soils*:57.

Hansen, J.L., D.R. Viands, R. Deubler, J. Neally, E. Thomas, J. Yaeger, M. Davis, and J.K. Waldron. 2008. New York 2006 alfalfa variety trial results. *Forage and Grazinglands*. <http://www.plantmanagementnetwork.org/sub/cm/trials/2006/alfalfa/Hansen.xls>

Hansen, J.L., D.R. Viands, R. Deubler, J. Neally, E. Thomas, J. Yaeger, M. Davis, and J.K. Waldron. 2008. New York 2007 alfalfa variety trial results. *Forage and Grazinglands*. <http://www.plantmanagementnetwork.org/sub/cm/trials/2007/alfalfa/Hansen.xls>

Hansen, J.L., D.R. Viands, J.K. Waldron, M. Hall, J. Losey, D. Johnson, and J. Hanchar. 2008. Reducing potato leafhopper (PLH) impacts on alfalfa through PLH-resistant cultivars intercropped with perennial forage grass. *North Amer. Alfalfa Improv. Conf.*,

1-4 June 2008. Dallas, TX.

<http://www.naaic.org/Meetings/National/2008meeting/proceedings/proceedings2008.htm>

Hansen, J.L., J.K. Waldron, J. Losey, D.R. Viands, and J. Hanchar. 2008. Agronomics and economics of potato leafhopper (PLH)-resistant alfalfa intercropped with perennial forage grass for PLH control. NYS Integrated Pest Mgt. Project Repts. 2007-2008. NYS IPM Pub. No. 506. 110-125.

Papadopoulos, Y.A., R. Michaud, A. Bertrand, B. Coulman, S.N. Acharya, S. Bittman, D. Viands, H. Riday, A. Boe, S.A.E. Fillmore, and Y. Castonguay. 2008. Response to selection under controlled environment versus natural selection in diverse regions across Canada. North Amer. Alfalfa Improv. Conf., 1-4 June 2008. Dallas, TX.
<http://www.naaic.org/Meetings/National/2008meeting/proceedings/proceedings2008.htm>

Papadopoulos, Y.A., B. Coulman, R. Michaud, S.N. Acharya, S. Bittman, D. Viands, H. Riday, A. Boe, T. Phillips, M. D. Casler, and S. A. E. Fillmore. 2008. Forage breeding and new varieties. Abstr. Can. J. Plant Sci. 88: (in press).

Papadopoulos, Y.A., B. Coulman, R. Michaud, S.N. Acharya, S. Bittman, D. Viands, H. Riday, A. Boe, T. Phillips, M. D. Casler, and S. A. E. Fillmore. 2008. Forage breeding and new varieties. Proc. 41st Biennial Atlantic Agron. Workshop. (invited presentation). Organized by Can. Soc. of Agron. at the Rodd Charlottetown Hotel, Charlottetown, PEI.

Papadopoulos, Y.A. S. Todd, K.B. McRae, S.A.E. Fillmore. 2008. (Abstract). The identification of perennial ryegrass and 'Festulolium' cultivars adapted for production in Atlantic Canada. Can. J. Plant Sci. 88: (in press)

Riday, H., S. Wagner, D. Viands, J. Lamb, D. Meyer, M. Smith, E.C. Brummer, and A. Boe. 2008. Sativa by falcata alfalfa hybrid variety trials. North Amer. Alfalfa Improv. Conf., 1-4 June 2008. Dallas, TX.
<http://www.naaic.org/Meetings/National/2008meeting/proceedings/proceedings2008.htm>

Teclé, I.Y., J. L. Hansen, A.N. Pell, and D.R. Viands. 2008. Divergent phenotypic selection for alfalfa cell wall fractions and indirect response in digestibility. Can. J. Plant Sci. 88:891-898.

Viands, D.R., J.L. Hansen, E.M. Thomas, and J.L. Neally. 2007. Registration of 'ReGen' alfalfa. J. Plant Registrations 1:106.