Sustainable Dairy Cropping Systems Designed to Produce Forage, Feed and Fuel

Our goal is to sustainably produce the forage, feed and fuel for a 65 cow, 240-acre dairy farm in Pennsylvania and to minimize off-farm inputs. With funding from a NESARE USDA grant, our team of PSU and USDA-ARS scientists designed two cropping systems to: 1) minimize nutrient and soil loss, build soil organic matter and nutrient pools, and promote biological processes for nutrient acquisition, 2) enhance biological diversity and ecological interactions, and 3) be energetically efficient, productive, profitable, and sustainable.

We consulted with an Advisory panel to ensure that the cropping systems are relevant to farmers and researchers. Using farm-scale equipment and manure from a neighboring dairy, we initiated the cropping systems in spring 2010 at 1/20th scale on 12 acres of Penn State's Russell E Larson Agronomy Research Farm. The cropping system strategies include two six-year rotations with legumes, cover crops, perennials, no-till, and manure injection. To reduce herbicide-use and herbicide resistance, we are evaluating a combination of weed management practices including a cover crop roller-crimper, herbicides applied over the crop row, a high-residue cultivator, tillage once in 6 years, and companion crops. We have also included a conventionally managed corn-soybean grain rotation for research comparison purposes, which adds another acre to what we manage.

Canola provides fuel for a straight vegetable oil-powered tractor and meal for the dairy ration. Winter canola is included in both crop rotations to evaluate approaches for integrating canola into dairy crop rotations. Preliminary energetic efficiency analysis of the cropping system indicated that 40 acres of winter canola has the potential to produce all of the tractor fuel needs for our 240 acre farm.

To evaluate the performance of the cropping system strategies, we are monitoring performance indicators such as crop yield and quality, soil health, nutrient conservation, greenhouse gas emissions, weed, insect, and mycorrhizal populations; energy use and production; and farm profitability. Twelve field "lysimeter" areas (90' x 50') were installed, to compare the impact of the manure management strategies on nitrogen, phosphorus and soil conservation, as well as atmospheric emissions (ammonia, greenhouse gases). Using the crop yields and feed and forage quality results, two dairy nutrition and production models are used to predict the performance of the virtual dairy herd.

In collaboration with four county educators, eight farmers and four commercial manure haulers, we are also demonstrating manure injection, cover crops, and the roller-crimper on farms in Bradford, Franklin, Lancaster, Lebanon and Berks Counties in PA with funding from a Conservation Innovation Grant from NRCS. We invite farmers in these regions who are interested in trying these practices to contact our project team.

Project Team:
Craig Altemose (2010-12), PSU Cooperative Extension Dir. Centre Co.
Timothy Beck, PSU Extension Ed., Ag Bus. Management, Cumberland Co.
Douglas Beegle, PSU Soil Science
William Curran, PSU Weed Science
Curtis Dell, USDA-ARS Univ. Park Soil Science
Ronald Hoover, PSU Coordinator of On-Farm Research
Virginia Ishler, PSU Dairy & Animal Sciences
Heather Karsten, PSU Plant Science, Project Director
Peter Kleinman, USDA-ARS Univ. Park Soil Science
Roger Koide (2010-12), PSU Plant Science, Mycorrhizae
Glenna Malcolm, PSU Plant Science, Research Associate/Project Manager
Tom Richard, PSU Agricultural and Biological Engineering
John Tooker, PSU Entomology

Graduate Students:
Maggie Douglas (2010-2012), Entomology; Emily Duncan, Plant Science; Kristin Haider (2010-2012), Ecology; Robert Meinen, Plant Science; Gustavo Camargo, Ag Engineering; Elina Snyder, Plant Science

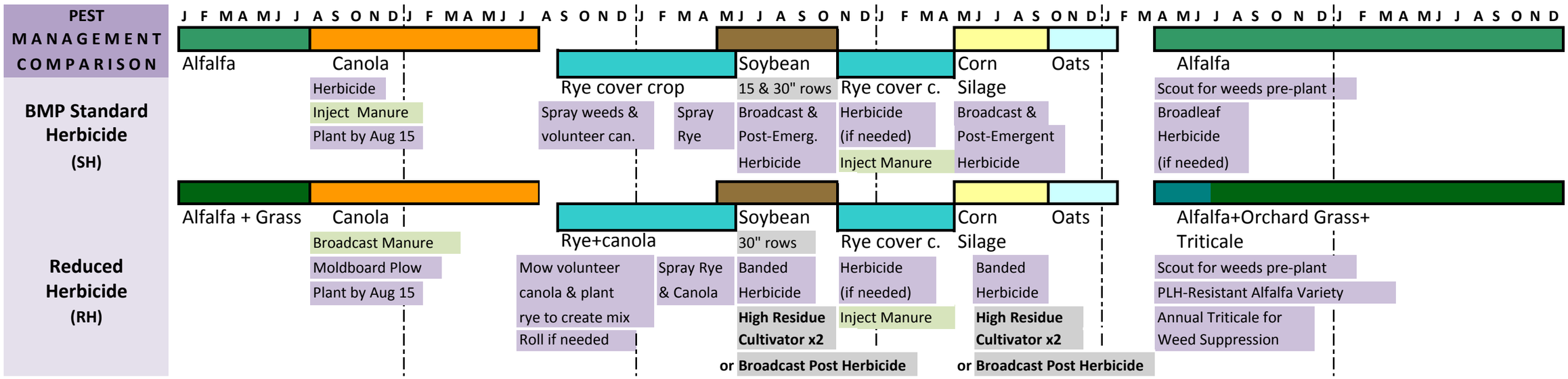
Technical Support:
Scott Harkcom, PSU Agronomy Farm Manager
Gordon Folmar, USDA-ARS Univ. Park, Hydrologic Technician
Louis Saporito, USDA-ARS Univ. Park, Soil Scientist
Dave Sandy, PSU Weed Science, Lab & Field Manager
Justin Dillon, PSU Senior Extension Associate
Matt Peoples, PSU Lab Technician, Dept. of Plant Science
Andrew Aschwanden, PSU Lab Technician, Dept. of Entomology
Al Cook, PSU Lab Technician, Dept. of Plant Science

Undergraduate Research Assistants:
Caitlin Andler, Fabien Balaguer (France), Benjamin Crooke, Díanna Duran (Costa Rica), Brian Gray, Allison Lush ,Heidi Musshafen, Marissa Keys, Curtis Kennedy, Andrew Kirk, Roni Pasi, Andrew Puglia, Sarah Rihl, Erika Samain (France), Julie Schubert, Adam Seitz, Joshua Walker

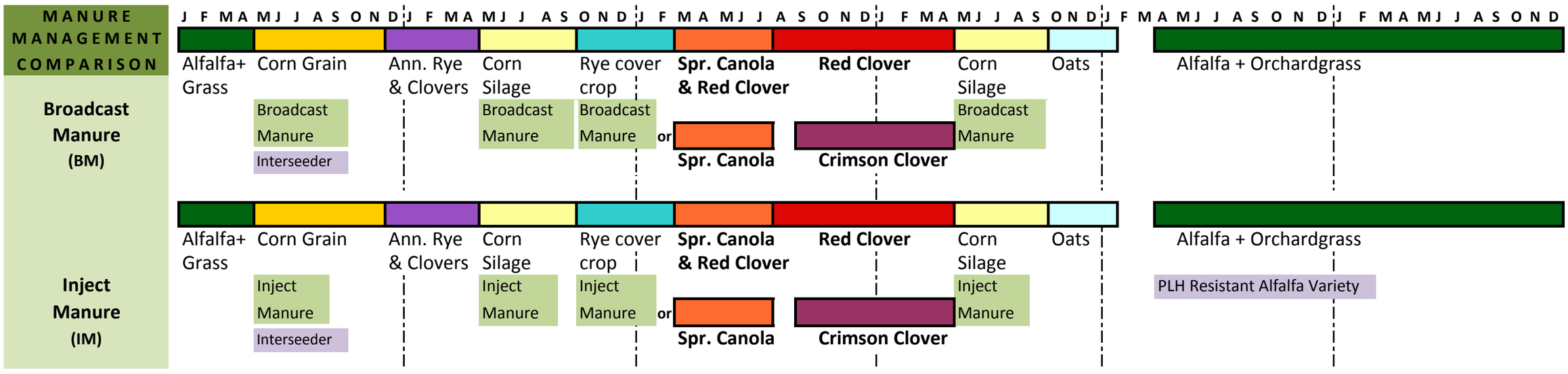
Project webpage: http://cropsoil.psu.edu/research/cropping-systems

2013-2015 PENN STATE SUSTAINABLE DAIRY CROPPING SYSTEMS (All systems are no-till, except in the 'Reduced Herbicide Grain Rotation') April 11, 2013

Pest Management Rotation: IPM for insect pests, multiple tactics for weed control (RH), inject manure for canola (SH) and rye cover crop before corn silage



Manure Management Rotation: injection vs. broadcast manure, green manure comparison, standard herbicides, IPM for insect pests, and non-Bt corn



Corn-Soy Conventional Grain Rotation: manure or fertilizer, standard herbicide regime, prophylactic insecticides, and Bt corn