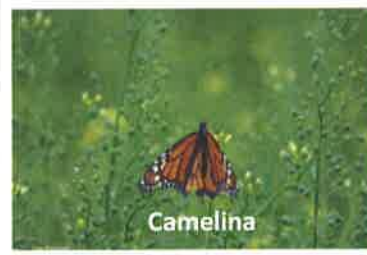


PERENNIAL CROPS

- Intermediate wheatgrass Kernza® – wheat-like grain, forage, biomass
- Perennial sunflower – edible seeds, oil
- Native polyculture grassland mixtures – biomass, forage, natural products
- Perennial flax – edible oil
- Kura clover – N-fixing cover crop
- Silphium – edible oil



WINTER ANNUAL CROPS

- Pennycress – oil, biofuel, cover crop
- Camelina – edible oil, biofuel, cover crop
- Winter barley – food, malting barley
- Hairy vetch – cover crop, N-fixation



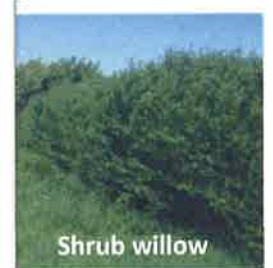
NATIVE WOODY CROPS

- Hazelnut – nuts, edible oil
- Shrub willow – biomass
- Elderberry – antioxidant-rich fruit
- Agroforestry – woody and herbaceous crop mixtures for feed, food and fuel



WHO IS FOREVER GREEN?

Forever Green is composed of teams of researchers, farmers, food product developers, and entrepreneurs from all aspects of the agricultural supply chain whose goal is to develop and promote the use of new crops that enhance water and soil quality. Each of the new agricultural enterprises listed above requires a unique strategy for implementation. The Forever Green team is focused on ensuring that these enterprises strengthen Minnesota's economy while protecting water, soil, and other natural resources.



WEBSITE

<http://www.forevergreen.umn.edu>

Contact

Dr. Don Wyse, wyses001@umn.edu, 651 470 9878
 Dr. Nick Jordan, jorda020@umn.edu



The Forever Green Initiative: Developing New Perennial and Winter Annual Crops to Enhance Minnesota's Soil and Water Resources



Why Forever Green?

Preservation of our natural resources is important to the quality of life and health of all Minnesotans. Among these resources, clean water is one of the most important to the citizens of the "Land of 10,000 Lakes."

- The health of Minnesota's lakes, rivers, and ground water is threatened by non-point sediment and nutrient pollutants originating from urban and agricultural systems.
- The human health risks, ecosystem impacts and economic losses related to degraded water resources result from land-use practices in both urban and rural areas.
- Agriculture can provide the solutions that preserve and conserve two of Minnesota's most precious resources, soil and water.



Forever
Green

For Minnesota to meet proposed water quality goals, winter annual and perennial crops need to be integrated into Minnesota's agricultural landscapes. The **Forever Green Initiative** at the University of Minnesota is positioned to develop these new winter annual and perennial crops, with associated efficient farming systems, that will lead to improved water quality, and management of water quantity, while bolstering the rural and agricultural economy with high-value, commercially marketable food, feed, and fuel products. Perennial and winter-annual crops—working in tandem with summer annuals—can capture solar energy, water and nutrients with very high efficiency.

Specifically, these production systems can:

- Diversify economic opportunities for Minnesota's farmers, through the production of new sources of food, feed, and high-value biomaterials, without interfering with current annual production systems.
- Provide ecosystem services such as clean water, healthy soil, pollinator forage and habitat.
- Enable abundant production despite climate variability and new pest and disease pressures.
- Enhance rural communities by creating new industries based on renewable agricultural resources and employment opportunities.
- Attract high quality talent to the University of Minnesota to meet the future workforce needs of the agriculture, food, energy and natural resource based industries in Minnesota.



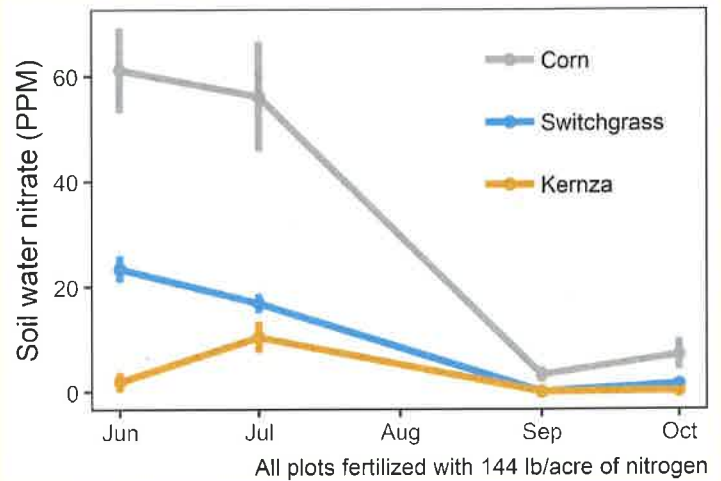
Forever Green Crops:

New Tools for Keeping Nitrates Out of Our Water

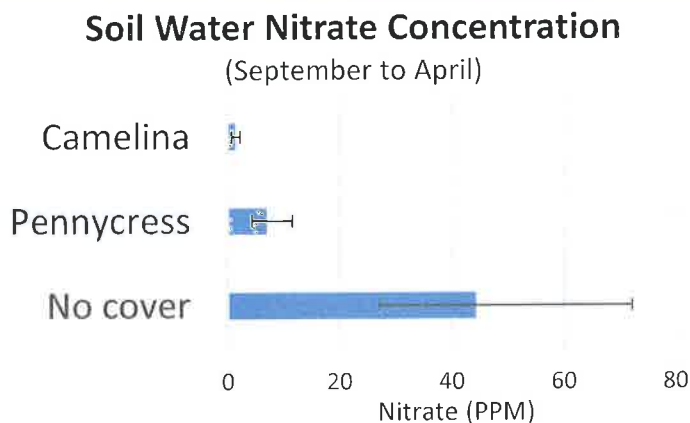
The Forever Green Initiative at the University of Minnesota is developing new, profitable crops that cover the soil all year. These crops hold soil and stop nitrates from leaching into ground and surface waters. A few of our most advanced crops include the following:

Kernza® Intermediate Wheatgrass

- Pioneering perennial grain that protects soil from erosion, runoff and leaching
- Deep root system builds soil health and organic matter
- Reduces soil water nitrate concentration by **up to 97%** compared to corn¹



Pennycress and Camelina



- New cover crops that have cash value as oilseeds
- Planted in the fall, take up nutrients over the winter
- Reduce nitrate concentration by **up to 97%** compared to no cover (standard practice)²

Find more information at www.forevergreen.umn.edu

¹ Jungers et al. 2019. Agriculture, Ecosystems and Environment.

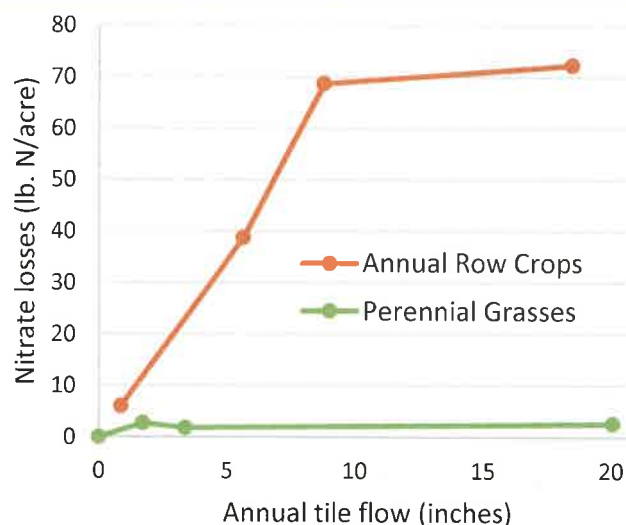
² Weyers et al. 2019. Journal of Environmental Quality.



flickr: Joe Thomissen

Perennial Crops Reduce Tile Flow and Streambank Erosion

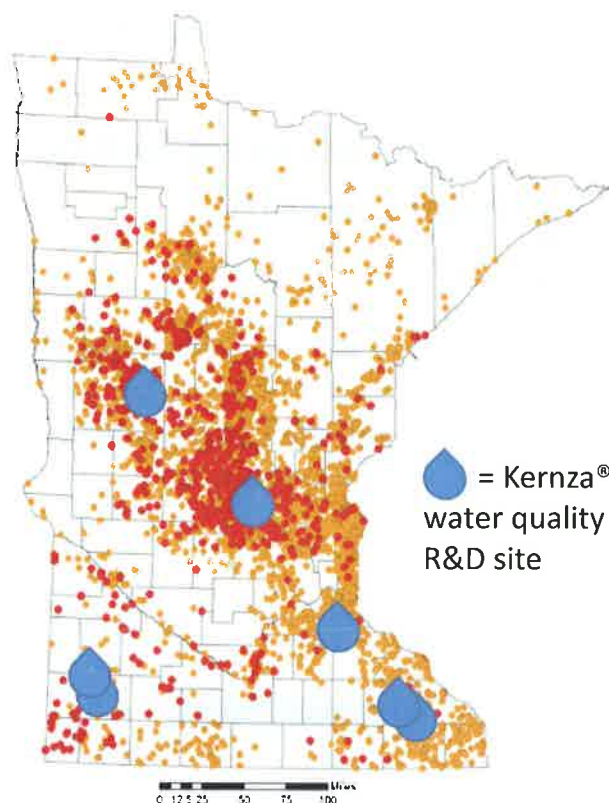
- Perennial crops can reduce nitrate losses through tile lines by **over 95%**³
- Growing perennials on 15% of a small watershed can reduce sediment loads by **over 22%**⁴



We Are Testing Forever Green Crops in Real-World Implementation Studies

- Large-scale Kernza® plantings in wellhead protection areas in Chatfield, Lincoln-Pipestone, Staples, Cold Spring
- Measuring nitrates in soil water
- Demonstrating feasibility for public utilities and private farmers

Nitrate in Private Wells



Prepared by the Minnesota Department of Health, October 21, 2014

Find more information at www.forevergreen.umn.edu

3/14/2019

³ Randall et al. 1997. Journal of Environmental Quality.
⁴ Dalzell and Mulla. 2018. Journal of Soil and Water Conservation.

Forever
Green