

University of Minnesota Forever Green Initiative Annual Progress Report to the Legislature

Per the requirements set forth in Minnesota Statute 3.197, the cost to prepare this report was \$300.

Submitted February 1, 2025 by Mitch Hunter (mhunter@umn.edu), Co-Director of the Forever Green Initiative and Adjunct Assistant Professor in the Department of Agronomy and Plant Genetics, UMN College of Food, Agricultural and Natural Resource Sciences (CFANS)

The Forever Green Initiative received \$802,000 in AGREETT funding in FY24.

Abstract:

The Forever Green Initiative (FGI) at the University of Minnesota is developing and improving winter-hardy annual and perennial crops that protect soil and water while driving new economic opportunities for growers, industry, and communities across Minnesota. By combining these novel crops with traditional annual crops, farmers can keep the soil covered all year round. This approach to farming with “continuous living cover” can greatly enhance the efficiency and sustainability of Minnesota agriculture. Uniquely, FGI combines basic research with crop commercialization efforts, so that it can be profitable for farmers to produce these crops across rural Minnesota. This comprehensive approach moves new crops out of the lab and onto the landscape, where they can make a difference for farmers, the environment, industry, and society. The FGI portfolio includes over 15 crops (Figure 1), each supported by a multidisciplinary team that may include expertise in the areas of genomics, breeding, agronomics, natural resource sciences, food science, sociology, economics, and commercialization.

The AGREETT funding from the Legislature provides long-term stability for key FGI personnel, including crop breeders and staff leadership. The past year saw tragic loss and change within the leadership of FGI, as our Co-Founder and Co-Director Dr. Don Wyse passed away in July. However, the support from AGREETT allowed us to confidently move forward in identifying a successor (Dr. Mitch Hunter) and adjusting the FGI leadership structure to better manage our expanding program. In addition, the AGREETT support allowed four key breeding programs to continue making progress. It also stabilized our Commercialization, Adoption, and Scaling program, which leveraged the funds to help secure a large new philanthropic grant.

All AGREETT funds were provided directly to FGI; none were used for finance or other UMN administrative costs. However, two of the personnel covered by this funding, Hunter and Cureton, have administrative duties directly related to Forever Green operations, such as budgeting, project management, and grant program administration.

Forever Green Initiative Crop Portfolio



Perennial Crops

Kernza®
 Perennial wheat
 Perennial oats
 Perennial cereal rye
 Perennial flax
 Silphium/silflower
 Perennial sunflower
 Alfalfa
 Kura clover
 Native polyculture
 grassland mixtures

Winter Annuals

Winter camelina
 Pennycress
 Winter barley
 Winter & spring field pea
 Winter hybrid rye
 Winter durum
 Hairy vetch

Native Woody Crops

Hazelnuts
 Elderberry
 Shrub willow
 Agroforestry

Figure 1. The Forever Green Initiative crop portfolio.

Objectives and Accomplishments:

1. **Advance perennial grain breeding and crop development.** Dr. Prabin Bajgain is the lead breeder on Kernza® intermediate wheatgrass (*Thinopyrum intermedium*), perennial cereal rye, and other perennial cereal grain crops, which protect soil and water quality while providing highly nutritious grains as well as livestock forage. In the last year, Dr. Bajgain has significantly advanced his breeding programs. The second Kernza variety has been approved for release in 2025, bringing improved genetics to Minnesota farmers, and there are 22 new variety candidates. The Kernza breeding program is significantly expanded and continues to make progress on key traits including higher yield, larger seeds, reduced shatter, and improved free threshing. The perennial cereal rye breeding program is newer, but it is growing rapidly, and four variety candidates have been established. Dr. Bajgain initiated a collaboration with a farmer in Farmington, MN to evaluate variety candidates and expand the seed supply on the farm, which can help accelerate future variety releases. Dr. Bajgain has also acquired \$790,000 of grant funds, has submitted four additional grants, and has two more in preparation. In the last year, he has published 6 peer-reviewed papers, given 3 invited talks, and participated in 4 field

days and outreach events. He is currently co-advising a PhD student and mentoring and supervising three undergraduate students.

2. **Advance winter oilseed breeding and crop development.** Dr. Julia Zhang is the lead breeder on domesticated pennycress (*Thlaspi arvense*), a novel winter oilseed crop for Minnesota that can protect the soil while providing feedstock for low-carbon fuel and high-protein meal for animal feed. In the last year, Dr. Zhang has reached important milestones in her pennycress breeding program. She has developed 5 elite breeding lines using backcrossing and marker assisted selection. These lines have strong agronomic performance and now contain key domestication genes developed by an FGI colleague, Dr. David Marks. Dr. Zhang has created a full breeding pipeline, conducted multi-location trials, and integrated new technology to her breeding program. She led studies in the biology and genetics of pennycress, including a project to create a genetic linkage map and investigate the genomic structure. Dr. Zhang has initiated interdisciplinary research collaborations and helped acquire \$905,000 of additional grant funds; one grant proposal is currently pending. She has interfaced with industry partners, educated the public at the State Fair, and presented on pennycress breeding at the Plant & Animal Genomics Conference 2024 and elsewhere. She has had one new paper accepted and another is under review. She mentored an IPREFER undergraduate intern in 2024 and has supervised numerous undergraduate students.
3. **Advance winter and spring pea breeding and crop development.** Dr. Steve Mulkey is the lead breeder on winter and spring pea, a key ingredient for the emerging plant-based protein market that also improves soil fertility and can cover the soil over the winter. Dr. Mulkey is rapidly growing this relatively young breeding program. In the last year, his program generated 400-500 unique crosses between winter and spring pea accessions; planted field trials for 9 projects in St. Paul, MN; expanded field trials to five locations throughout Minnesota; and have performed multiple controlled environment freeze tests to characterize the USDA's winter pea accessions. Eight spring pea field trials were concluded to help identify superior spring lines for crossing with winter lines. Dr. Mulkey has completed two intercropping studies, one with winter pea and winter barley and another with spring pea and oats. He is collaborating closely with pea breeders across the country and overseas to advance pea biology and expand trialing locations. Dr. Mulkey leads data analysis for his many trials and is adopting novel, powerful data analysis methods. In the last year, he presented to six different professional audiences and helped secure \$488,260 in grant funding.
4. **Advance hybrid hazelnut breeding and crop development.** Dr. Lois Braun is the lead breeder on hybrid hazelnuts, a high-value agroforestry crop that provides delicious nuts as well as wildlife habitat, carbon sequestration, and water quality benefits. In the last

year, Dr. Braun has advanced her breeding program on multiple fronts. She hired a highly qualified PhD plant breeder postdoctoral researcher, Dr. Emily Delorean, who is bringing new technologies and methods into the breeding program. Dr. Braun's team evaluated eight acres of mature F1 crosses and harvested 150 plants for yield and quality, to select the best to move forward in breeding. They also produced vegetative clones of 30 top selections to complete four new replicated germplasm trials; harvested seeds from controlled pollinations between top F1s and top Midwest selections; and planted 700 backcross seedlings into the field in St. Paul. Dr. Braun' explored multiple approaches to more efficiently produce vegetative clones of top plants, which is a bottleneck in the breeding program. She led research on planting grasses within hazelnut rows, established a trial on nutrient needs of older hazelnut stands, and submitted a grant to evaluate using leguminous cover crops in hazelnut plantings. Dr. Braun supported the burgeoning regional hazelnut industry through one-on-one conversations with growers, farm visits, and numerous field days and webinars. She helped develop three grant proposals.

5. **Enhance FGI's management capacity and prepare for leadership transition.** Dr. Mitch Hunter transitioned from Associate Director to Co-Director of FGI in August, following the loss of Dr. Don Wyse. While this transition was anticipated, it came much sooner than anyone expected. AGREETT support was essential to achieving a smooth transition since having a stable source of funding helped assure the FGI Executive Committee that Dr. Hunter will be able to help lead FGI for the foreseeable future. Dr. Hunter has taken on overall leadership of FGI, alongside longtime Co-Director Dr. Nick Jordan. He devotes significant time to strategic partnerships, fundraising, team management, budgeting, and strategic planning. He continues to have primary responsibility for supporting the crop research teams, overseeing the FGI grant program, and leading the FGI Executive Committee, which is made up of the FGI Co-Directors, Program Directors, and six elected faculty members. In the last year, Dr. Hunter has secured a \$10,000,000 grant from the Department of Energy to advance research on the winter oilseed crops; advanced a proposal that is included in the LCCMR recommendations that would provide an additional \$2,146,000 for the FGI Grant Program; cemented a collaboration agreement with Cargill, Inc. focused on the oilseeds; participated in licensing discussions around multiple FGI crops; and administered existing FGI grants. Hunter has also helped advance a multi-sector effort to develop a study outlining the "Path to 1 Million Acres of Winter Oilseeds" with a coalition including MPCA, MDA, Friends of the Mississippi River, Minnesota Environmental Partnership, MBOLD, the SAF Hub, the McKnight Foundation, Cargill, and agricultural groups.
6. **Advance the commercialization, adoption, and scaling of FGI crops.** Colin Cureton, MS, is the Director of Commercialization, Adoption, and Scaling. Cureton provides

management, strategy, and operational leadership in bridging new perennial and winter annual crops to the wide range of stakeholders involved in advancing their success on the landscape and in the market. Cureton also provides program leadership for FGI, serving on the leadership team and the Executive Committee, and informing overall strategy. He manages 3.8 FTE on his Commercialization, Adoption, and Scaling Team. In the last year, his team has engaged with a wide variety of commercial partners, including large companies like Delta Airlines, Hormel, General Mills, Cargill, and Rahr Malting and smaller ones including Perennial Promise Growers Coop, Arcola Farms, Perennial Pantry, Albert Lea Seedhouse, American Hazelnut Company, and many others. In addition, enrollment in the MDA-funded EECO Implementation program has tripled from 1,000 acres of Kernza to 3,000 acres made up of Kernza, winter camelina, hybrid rye, and a few acres of winter barley. EECO supports growers through technical assistance (TA), environmental benefit payments, risk management payments, and seed and grain testing. Cureton's team is working to expand the hazelnut "Go-First Farm" program to more pioneering farms in Minnesota. They put on a broad suite of field days and conference presentations throughout the year, largely focused on growers and TA providers. Cureton secured a \$1,500,000 grant from Builders Initiative, a philanthropy, to develop and implement a new CLC market development strategy for industry partners of varying sizes. Cureton's team has handled over 30 Plant Material Transfer Agreements to facilitate commercial and research collaborations and also advised on the re-licensing strategy for the first Kernza variety, MN-Clearwater, and the strategy for the second Kernza variety, approved for release in December, 2024. Cureton is leading implementation of the "Path to 1 Million Acres of Winter Oilseeds" study.