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NOTICE

This IPREFER project quarterly report was prepared by Western Illinois University and IPREFER research colleagues from CoverCress, Inc., Illinois State University, McLean County Soil and Water Conservation District, The Ohio State University, United States Department of Agriculture-Agricultural Research Service, University of Illinois, University of Minnesota, and the University of Wisconsin-Platteville in the course of performing academic research supported by Agriculture and Food Research Initiative Competitive Grant No. 2019-69012-29851 from the United States Department of Agriculture National Institute of Food and Agriculture (“USDA-NIFA”).

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Integrated Pennycress Research Enabling Farm and Energy Resilience
(AFRI-CAP 2019-69012-29851)

Year 1 Project Executive Summaries
September 1, 2019 – August 31, 2020

Project Administration

- Win Phippen, Western Illinois University, wb-hippen@wiu.edu
- Anne Kinzel, anne.kinzel@iprefercap.org

The IPREFER project was initiated with the specific goal of commercializing pennycress production by 2021. With several University and USDA collaborators and a single corporate partner, we are adapting the project to unforeseen challenges and are well on our way to meeting our goal. In our first year, we found ourselves having to re-organize our research objectives to better suit commercialization efforts. Additionally, we had to adjust all our education and outreach activities in response to COVID-19.

Significant Accomplishments – Year 1

- We held our first annual meeting in Normal, IL, hosted by Illinois State University (ISU) on August 11-13, 2019.
- We hired a Program Manager, Anne Kinzel. With Anne’s previous experience managing a NIFA-CAP project, we were able to hit the ground running.
- We established a project website: www.IPREFERCAP.org and a social media presence (Twitter (@IPREFER_CAP) and YouTube (https://www.youtube.com/channel/UCIIIn60frd0FUyXGF1pVH0SQ).
- We created a project media kit to acquaint the media with IPREFER. The project was featured in a number of articles in ag-centric publications, including Illinois Farmer Today and The Furrow (John Deere) as well as in daily print media.
- We established a program governance scheme by creating an Executive Leadership Team and establishing a five-member Advisory Board.
- We created a project newsletter, the PennyPulse. The newsletter, hosted by MailChimp, is published bi-monthly. The goal is to keep project participants committed and connected to the broader goals of the project.
• We completed a contract agreement for our project’s first program pivot with Southern Illinois University (SIU) to conduct much-needed experiments on soybean cyst nematodes (SCN).

Planned Activities, Outcomes, and Impacts - Year 2

• Conduct a virtual second annual meeting on August 3-4, 2020. The meeting focused on highlighting Year 1 accomplishments and organizing Year 2 activities.

• Increase awareness of the IPREFER project through the IPREFER website, YouTube, and Twitter accounts.

• Conduct bi-annual research meetings for each objective team during the 2021 winter months. These meetings will allow for a more comprehensive evaluation of the research objectives for each team.

• Work more closely with corporate partner CoverCress to better understand the required commercialization needs and how to integrate these needs into the university research setting.

• Oversee the implementation of the data management plan. Our goal is to avoid ‘data dumps’ on the general public.

Executive Summary - Agronomic Management

Co-Project Directors

▪ Alexander (Alex) Lindsey, The Ohio State University lindsey.227@osu.edu
▪ M. Scott Wells, University of Minnesota mswells@umn.edu

Agronomic Management: A suite of agronomic management projects will be deployed across the region to position pennycress in the predominate corn and soybean rotation and in a range of high-valued rotational crops. We will:

• Develop regionally-based agronomic management practices for establishing pennycress in grain corn systems.

• Quantify soybean and pennycress yield trade-offs across soybean maturity group (MG) and cropping systems.

• Establish weed and pest best management strategies that support pennycress integration in corn and soybean production systems.
Significant Accomplishments – Year 1

- Even with the issues around COVID-19, our teams across the network, except for Wisconsin, were able to deploy three of the four agronomic studies. Unfortunately, the University of Wisconsin-Platteville was subject to more stringent COVID-19 restrictions than our other sites.

- The Agronomy Team planted corn for both Corn residue Management (CRM) and DISC at all sites, except for Wisconsin. DISC is the abbreviation we use for the IPREFER corn stover management project. Nicholas Heller (University of Minnesota) leads this IPREFER objective.

- We were able to plant pennycress in fall 2019 for the SOYSELECT project (i.e. evaluates relayed soybean phenotypes and cultivars in pennycress for imported performance) at two sites. Soybean was relayed into the pennycress and monitored throughout the summer. We will harvest soybean this fall.

- We have put the PELLET project on hold until the fall of 2021. PELLET is the abbreviation we use for the “Novel Seed Treatment for Improve Pennycress Performance” part of the project. This IPREFER objective is led by Alex Lindsey at Ohio State University.

Planned Activities, Outcomes, and Impacts - Year 2

- In Year 2, all Agronomy Team sites plan to harvest corn, apply treatments, and plant pennycress. In addition, Agronomy Team members will plant pennycress seed increases.

- In Minnesota, we will plant the pennycress for the SOYSELECT project in fall 2020.

- In Year 2, the entire Agronomy Team will meet to discuss Year 1 findings and make any need adjustments. For example, the breeding core provided new genetics for the agronomy team’s next series of studies. The Minnesota team planted the increase of the new line. During our annual meetings, the team will assess and deploy the next round of agronomic projects.

Executive Summary - Breeding and Genomics – Pennycress Improvement

1 DISC is the abbreviation we use for the IPREFER corn stover management project. Nicholas Heller (University of Minnesota) leads this IPREFER objective.

2 “PELLET” is the abbreviation we use for the “Novel Seed Treatment for Improve Pennycress Performance” part of the project. This IPREFER objective is led by Alex Lindsey at Ohio State University.
Co-Project Directors

- M.David Marks, (LEAD Northern Genetics), University of Minnesota, marks004@umn.edu
- John Sedbrook (LEAD Southern Genetics), Illinois State University, jcsedbr@ilstu.edu

Pennycress Improvement: Our research teams have generated high-yielding pennycress breeding lines through multi-state testing and identified/validated trait-improving mutations and natural variants. Throughout the project will:

- Utilize marker-assisted selection and CRISPR gene editing to complete introgression of these traits into elite breeding lines.
- Extend our replicated yield testing program to a cooperative regional program and rapidly identify the best lines for each Midwest location (IL, MN, OH, WI) in conjunction with the commercial launch.
- Perform field evaluations and seed increases of lines with commercial potential.
- Develop additional genetic/genomic resources for long-term breeding program success.

Significant Accomplishments – Year 1

- We successfully identified and stacked genetic changes conferring seed reduced erucic acid, reduced glucosinolate, and reduced fiber. These CRISPR-edited plants grow like wild type in growth chambers, have been confirmed to be CRISPR-construct-free, and will be planted in the field this September 2020.
- We successfully field-tested various stacked traits combinations forming the basis of commercial lines to be marketed by CoverCress, Inc.
- We successfully identified and stacked genetic changes conferring seed reduced erucic acid, reduced glucosinolate, reduced PUFA, and reduced shatter.
- We have achieved broader and more in-depth communication and data-sharing with our academic and commercial partners. This communication has helped all parties improve our breeding programs and line selection criteria and fine-tuned research objectives.

Plans for Year 2

- We will continue to develop elite breeding lines for domestication trait introgression. These lines will form the foundation of the UMN breeding program and will contribute to improved yields and increased stability under variable environmental conditions.
• We will continue testing and stacking in value-added traits, including higher total seed oil, larger seed size, and high oleic oil.

• We will continue the development of the mutant gene index and other plant genetic material.

Executive Summary - Characterization of Pennycress Ecosystem Services

Co-Project Director

- William Perry, Illinois State University  wlperry@ilstu.edu

Characterization of Pennycress Ecosystem Services: To quantify the benefits of pennycress as a winter cover crop, we will:

• Assess pennycress impacts on reducing nutrient flux, nitrogen, and phosphorus, from subsurface drainage throughout the year.

• Determine abundance and diversity of pollinating insects of pennycress, which flowers earlier than most other plants.

• Measure pennycress forage resources (pollen and nectar) for pollinators and characterize the health of both individual honey bees and colonies near pennycress fields.

Significant Accomplishments – Year 1

• Established nine replicate 2-acre plots with independent subsurface drainage (tile) and tile interceptors for sampling water discharge and nutrient loads and automated sampler platforms and enclosures.

• Established treatments of pennycress and spring amended nitrogen pennycress to compare to non-cover crop reference plots.

• Sampled soil fertility, organic carbon, and soil pore water in spring and fall and identified two races of soybean cyst nematodes from fall samples.

• Formed a collaboration to use drone imagery to obtain whole plot plant biomass and nitrogen sequestration along with a 2 cm digital elevation model to assess soil losses.

• Ordered automated samplers to estimate subsurface drainage nutrient loads and water discharge.

Planned Activities, Outcomes, and Impacts - Year 2

Annual Progress Report: September 2019 – August 2020
• Install six automated ISCO samplers to estimate nutrient losses in subsurface drainage systems, hopefully by November 2020.

• Establish robust stands of fall germinated pennycress to provide more significant potential weed reduction and nutrient immobilization.

• Sample fall and spring soil organic matter and fertility. Soil organic carbon will be sampled at multiple depths to better estimate soil organic carbon changes and add to an assessment of the carbon intensity score for pennycress.

• Sample dissolved nutrients in soil pore water in the fall and spring as this may respond faster than dissolved nutrients in subsurface drainage water.

• Establish a robust relationship between manual plant biomass and nitrogen content with drone imagery and determine carbon and nitrogen immobilization.

• Sample subsurface drainage losses of water and dissolved nutrients to determine differences in nutrient loads between treatments.

• Sample soybean cyst nematodes to determine if populations or races change in pennycress treatments.

Executive Summary - Life Cycle Supply Chain Development

Co-Project Director

- Cristine (Cris) Handel, CoverCress, Inc., chandel@covercress.com

Life Cycle Supply Chain Development: Pennycress seed storage and utilization are critical elements of the supply chain. We will:

• Optimize pennycress seed storage to ensure the sustained availability of quality seed.

• Develop tools that help farmers and industry adopt effective seed drying/storage protocols.

• Provide seed/oil to crusher/producers for conversion testing.

• Conduct seed meal animal feeding trials to generate data for regulatory approval.

Significant Accomplishments – Year 1

• We put together the supply chain team, including members from all related and external institutions.
• We started designing the whole supply chain structure and needed projects around it.

• We focused on economic analysis and carbon-related analysis (LCA), and carbon-intensity scores.

• We designed needed studies around grain cleaning, drying, and processing.

• We managed COVID-19 limitations to conduct meetings and field days.

Planned Activities, Outcomes, and Impacts - Year 2

• Assign responsibility and deadlines to conduct each of the needed studies that cover the whole supply chain.

• Have project partner Agricultural Utilization Research Institute (AURI) do the needed research around grain drying, storage, and processing.

• Complete LCA and economic studies.

Executive Summary – Education, Extension and Outreach

Co-Project Directors

▪ Rebekka Darner, rldarne@ilstu.edu

▪ Willy Hunter, wjhunte@ilstu.edu

Pennycress provides many new opportunities as a new crop. To raise awareness, train a skilled workforce, and enhance and inform pennycress adoption, we will:

• Provide research-based information (electronic, written, and oral) to farmers and seed handlers on germplasm advances, cropping rotations/systems, seed drying/storage, production economics, and conservation benefits.

• Engage 4-H and FFA youth, parents and administrators, and the public through presentations and demonstrations, and develop pennycress-based projects for youth to show at county and state fairs and conventions.

• Provide a series of field day demonstrations and on-farm question/answer sessions.

• Provide graduate and undergraduate students with interdisciplinary research training and education through internships and course-based experiences.

Significant Accomplishments – Year 1
Hosted eight undergraduate students in the 2020 IPS-URE program.

Conducted an inventory of existing cover crop lessons in the national *Ag-in-the-Classroom* database.

Met with local teachers and shared opportunities for using cover crops to teach traditional science content.

Led *Cover Crop Trivia* activity for 100+ 4-H members during the annual Clover Clinic learning event in Peoria, IL.

Wrote four of the 12 planned lessons for the 4-H Cover Crops project book.

Obtained IRB approvals to evaluate various IPREFER education and outreach efforts, including public events (i.e., field days) and the 2020 IPS-URE program See Exhibit C.

Reached over 200 people during the three-day virtual field days.

**Planned Activities, Outcomes, and Impacts - Year 2**

Host Cohort #2 of the IPREFER 2021 IPS-URE program.

Establish Cover Crop Science as a 4-H project category for the 2021 4-H County Fair exhibitions.

Engage 10-20 4-H clubs in hands-on activities and invite them to submit Cover Crop Science projects to the 2021 4-H fair.

Host three Cover Crop Science SPecial INterest (SPIN) Clubs.

Host hands-on workshops at two or more conferences for educators.

Present IPREFER educational outcomes or developed curricula at professional symposia.

Host a collection of native pennycress seed in collaboration with the Illinois Farm Bureau and other partners during Spring/Summer 2021.
“Our mission is to optimize off-season pennycress oilseed production

By overcoming production and supply chain bottlenecks.”

Dr. Winthrop B Phippen  
*Project Director*  
Professor of Plant Breeding and Genetics  
Western Illinois University  
School of Agriculture  
1 University Circle  
Macomb, IL 61455-1390  
Phone: 309.298.1251 or 309.298.1080  
Email: wb-hippen@wiu.edu

Anne Kinzel  
*Project Manager*  
Western Illinois University  
School of Agriculture  
Email: anne.kinzel@iprefercap.org