

## Introduction

This book is designed for youth in grades 6-8 to learn about cover crops. It can be used with 4-H projects and clubs, in schools, or in after-school or other out-of-school programs.

It was designed as a standalone project, but it does not need to be used in that way. It may be combined with other project areas or used as a part of a larger agriculture curriculum.

There are educator/facilitator implementation guides at <https://covercrops.cemastprojects.org/> to help you if you would like to use the materials here in a setting with multiple youths.



If you plan to use this book as a guide for a 4-H project, be sure to check with your county for additional record keeping guidelines and exhibit requirements.

## Background Information

What is a cover crop? A cover crop is planted off-season, or when the main cash crop is not being grown. As you will learn, cover crops have many benefits. They protect soil and provide food and shelter to many organisms.

Throughout this experience, we will investigate a variety of cover crops, but we will focus on one more than the others. Pennycress (*Thlaspi arvense L.*) is an oilseed cover crop which can offer all the benefits above. For more about current research, visit <https://iprefercap.org/>.

Pennycress can be harvested to make biofuels, cooking oils, and more. It is an appealing cover crop option for farmers.

Pennycress has not traditionally been used as a cover crop, but because it is being researched as we speak, it is the perfect place to start learning about cover crops. You will be learning about this specific cover crop alongside scientists throughout the Midwestern United States.

Scientists are exploring the potential of pennycress by working in a variety of teams.

The agronomy and crop management team is working to discover how to best plant and harvest pennycress, as well as how to minimize weeds and pests. We will explore this group's work in Modules 1A through 1C.

The breeding and genetics team is looking at how to help pennycress produce the most seeds with the most seed oil. We will look at this group's work in Modules 1D and 1E.

The ecosystems services team is working to identify the benefits pennycress has for soil, water, and pollinators. We will explore this group's work in Modules 2A and 2B.

The supply chain team is looking at how to take seeds and turn them into products like crayons, cooking oil, and biofuels. We will explore this group's work in Modules 2C and 2D.



## How to Use This Book

This book contains 9 modules. Each module includes several hands-on or minds-on activities. Though each module can be completed on its own, you will develop a better

knowledge base and have a richer experience if the modules are used in order. In this way, you will build on your previous learning and form connections to prior explorations.

### *Section 1:*

#### ***How are Cover Crops Grown & Developed?***

- Module A: A Plant Primer  
*What do flower parts tell us about plants?*
- Module B: Cover Crops in the Rotation  
*How do cover crops fit between cash crops?*
- Module C: Planting & Harvesting  
*Why do we build different farm machines?*
- Module D: Natural & Artificial Selection  
*What do we do to improve crops over time?*
- Module E: Gene Editing  
*How can we accelerate artificial selection?*

### *Section 2:*

#### ***What are the Benefits of Cover Crops?***

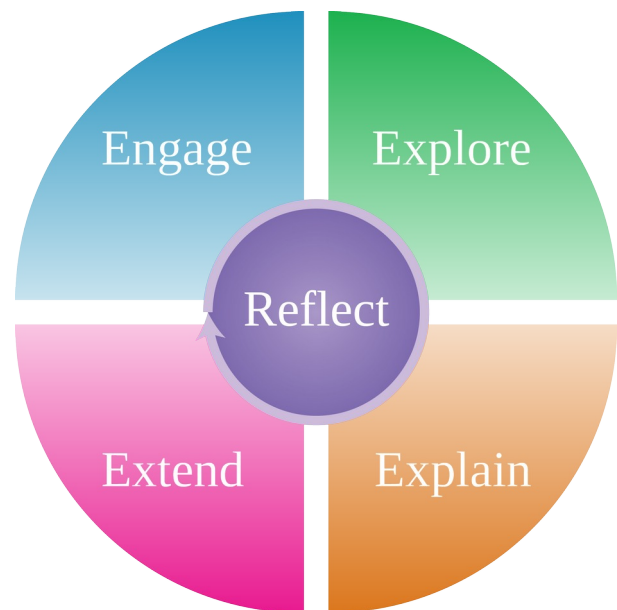
- Module A: Reducing Soil Erosion  
*How do we keep land healthy?*
- Module B: Pollinator Services  
*Which pollinators might we see in our field?*
- Module C: Cover Crop Products  
*What can we make from cover crops?*
- Module D: Crop Product Supply Chains  
*What happens to a crop after harvest?*

## A Note to the Project Helper

The help and support of an adult project helper can make a huge difference in the life of a young person! This might be an adult relative, a teacher, a 4-H leader, or a family friend. Knowledge of education or agriculture may be helpful, but any caring adult can fill this role.

As the young person works through the modules, the project helper can make sure activities are done safely. They can also provide support as the young person gathers materials and information. They might encourage reflection by asking additional questions as well as provide positive guidance and feedback. They should challenge the young person to continue their growth through new opportunities and constructive appreciation.

The modules in this book are arranged in an inquiry-based format that follows these stages:



- Introduce/Engage – Youth are introduced to the topic through pictures, web searches, readings, and other activities. This activity develops a driving question that will guide the rest of the module.



- Explore – Youth do an activity, monitor results, observe phenomena, and/or collect data related to the driving question.
- Explain – Youth analyze their results, observations, and data to develop an answer to the driving question.
- Extend – Youth apply their new knowledge to a different context. They make connections to the driving question.
- Reflect – Youth think through what they knew before and what they know now. Reflection can take place at every stage of the module, but specific reflection questions are given at the end.

These stages work together in a cycle, and some modules walk through the stages more than once.

Each module also highlights a career connection. These show how today's cover crop science learning can be the first step on a path to the future.

This project book centers around cover crop science, and it strives to help young people gain knowledge and skills in this topic. However, it is important to note that this project is also a vehicle for more holistic positive youth development (PYD). This matches the goal of all 4-H programming.

PYD strives to foster behaviors and attitudes in young people that will allow them to thrive throughout their life.

National 4-H Council has summarized essential elements of PYD with the acronym BIG-M. BIG-M stands for Belonging, Independence, Generosity, and Mastery. As a project helper, you can look for ways to build upon these elements within the project work.

### **Belonging**

- Develop a healthy and caring relationship with your young people.
- Ensure a physically and emotionally safe environment during project work.
- Remind young people that they are part of something bigger. This project brings youth into current, ongoing cover crop research taking place throughout the Midwestern U.S.

### **Independence**

- Allow young people to ask their own questions. They should follow their own unique areas of interest as you explore cover crops together.
- Serve in a supporting role as youth make their own decisions about their path through the project.
- Use the Career Connections to help young people see how their current and future decisions can impact their future.

### **Generosity**

- Ask young people how they can use their new skills and knowledge to give back to their larger community.
- Discuss the ways cover crops and other sustainable agriculture practices benefit everyone. Planet and climate health are important to all of us!
- Help young people brainstorm and carry out a service project or educational campaign focused on cover crops.

### **Mastery**

- Encourage young people to share or exhibit their new skills and knowledge.
- Challenge young people to deepen their skills and knowledge with further project work or further opportunities.
- Recognize effort, attitude, perseverance, and a willingness to try new things.





## ***About the Authors***

### **Matthew Hagaman, M.S., M.A.**

Matthew has been engaged in middle-level and higher education for over a decade, with a focus in science and technology education. When he is not exploring nature or writing curriculum, you may find Matthew making web sites or furniture.

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Rebekka is director of the Center for Mathematics, Science, and Technology at Illinois State University and a science education researcher. When she is not studying how non-scientists use STEM to make decisions, Rebekka enjoys gardening, yoga, and bouldering.

### **Rachel Sparks, Ph.D.**

Rachel is a biology education researcher who focuses on how students think about evolution. Evolution is an area which unites all of biology, but is especially visible in developing new plant and crop species. When Rachel is not working with scientists and non-scientists of all ages, you may find her exploring local parks, thrift shopping, or watching Star Trek.

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Emily has been engaged in youth development for nearly a decade, with a focus in STEM engagement and social-emotional development. When she is not leading a training, writing curriculum, or developing new partnerships, you may find Emily sitting on the floor of her office, building marshmallow catapults out of craft sticks or designing mazes for robots for her next STEM program.

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Willy Hunter is a professor of chemistry at Illinois State University. He works with teachers and faculty across the United States and internationally to improve science and math education in K-12 schools. When he is not investigating chemistry in the natural world, he can usually be found hiking, cycling, gardening, or engaged in another outdoor pursuit.

## ***Expert Reviewers***

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