4-H SCIENCE OF AGRICULTURE RESPONSE CHALLENGE
Quick Start Guide

Contents
What is This All About? ................................................................. 2
Welcome .............................................................................. 2
Issue and Response: Challenge overview .................................. 2
Team Timeline ........................................................................ 3
Summer: ............................................................................... 3
Fall/Winter: .......................................................................... 4
Spring/Summer: ..................................................................... 4
Youth and Adult Partnership ....................................................... 4
Team Members ........................................................................ 4
Volunteer Opportunities .............................................................. 4
The Challenge ........................................................................ 6
Science and Engineering Practices .............................................. 6
Identify an issue ........................................................................ 9
Judging Rubric ........................................................................ 9
Core Values ............................................................................ 10
Project .................................................................................... 10
Presentation ............................................................................. 11
Awards .................................................................................... 11
Reflect on and celebrate the Season ........................................... 12
Funding a SOAR Team ............................................................... 12
Tips for Beginning SOAR Teams ............................................... 12
Available Support ................................................................... 13
Acknowledgements ................................................................. 13
WHAT IS THIS ALL ABOUT?

WELCOME

Volunteers are a huge part of what makes 4-H Science of Agriculture Response possible. Whether you are a business person, parent, or volunteer, Science of Ag Response and Challenge would not exist without you. We just cannot say it enough – thank you!

We modeled this Quick Start Guide after FIRST® Lego League® as a guide to help you navigate the complete Science of Ag Challenge season. From recruiting your team members all the way through celebrating at the end of your season, this guide contains suggestions to help you along the way.

Remember though, this is only a guide. The 4-H motto, “Learn by Doing” is just as true for volunteers as it is for 4-H members. Use the guide to help you guide your team, but also enjoy the experience of learning alongside the kids. Don't forget, this is going to be fun!

Michael Compton
Extension Educator,
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ISSUE AND RESPONSE: CHALLENGE OVERVIEW

Issue
Agriculture and ag-biosciences are critically important to finding solutions to key challenges facing the United States, including economic growth, food security, human health and environmental sustainability. However, a U.S. Department of Agriculture survey showed the United States faces a shortage of agricultural scientists. The U.S. is falling dangerously behind other nations in developing its future workforce of agriculturists, scientists, engineers, and technology experts. Young people in America are not prepared with the necessary science, engineering and technology workforce skills to compete in the 21st century. Only 5% of American students get their undergraduate degree in science and engineering compared to 66% of Japanese and 59% of Chinese students. Statistics show that children lose interest in science, technology, engineering and math (STEM) topics as early as third grade.

University Response
As part of the University Of Minnesota Extension Center for Youth Development, 4-H has made improving science literacy a priority, and is working to develop the next generation of agriculture scientists. 4-H provides hands-on, experiential, inquiry-based learning opportunities that promote excitement and interest in science, and improve science literacy by equipping youth with science knowledge and skills. Through 4-H, youth:

• Gain exposure to cutting-edge science and technology in agriculture that produces abundant, healthy and economical food.
• See themselves as scientists.
• Explore college and careers in agriculture, science and engineering.
A study of youth development by Tufts University shows that young people who participate in 4-H excel in school and science, and are more likely to pursue a career in science, engineering or computer technology than their peers.

**4-H Science of Agriculture Response Challenge**

4-H knows that today's youth are tomorrow's agriculture leaders. The new 4-H Science of Agriculture Response (SOAR) asks youth to explore and develop science-based solutions to agriculture-related issues they have identified in their communities. Youth teams will work with local partners to explore issues and find solutions to challenges in agronomy, animal husbandry, soil science, Ag business, rural finance, food science and engineering. Participants will then attend a statewide event (Challenge) at the University of Minnesota Twin Cities campus to present their 4-H Science of Agriculture Response Challenge projects. They will also connect with representatives from the University and agribusiness community who are eager to meet the next generation of leaders in agriculture and STEM while sharing their job-seeking skills.

**Impact**

Through “hands on” 4-H agriculture, science, technology, engineering and math learning experiences in the Science of Ag Challenge, youth will:

- Get excited about and interested in agriculture and STEM;
- Have a greater understanding and knowledge of food production and its importance in our economy and world;
- Gain 21st Century skills, including technology, health, business and economic literacy, critical thinking, problem solving, initiative and self-direction;
- Consider and connect with agricultural-related studies at the university level; and
- Be exposed to and explore future careers in agriculture.

**TEAM TIMELINE**

Running a SOAR team takes organization and planning, but it is also a lot of fun! Below are checklists of essential tasks to help prepare for the season. Please keep in mind that these checklists are only intended as a starting point.

**SUMMER:**

4-H Science of Agriculture Response Challenge is promoted at county fairs, programs and community events. Coach is secured.

- If not already a screened and enrolled volunteer, contact 4-H program staff to complete the volunteer screening process and enroll as a 4-H volunteer.
- Identify others for volunteer roles (coordinator, mentor).
- Decide how team members will be identified or selected.
- Decide where and when your team will meet.
**FALL/WINTER:**

- 4-H Science of Agriculture Response teams form. Teams may be county or regional, and will partner with local partners to identify issues related to agriculture in their communities to address.
- Teams begin to meet and create a meeting schedule. Teams will need to set their own schedule, but should plan to meet weekly or every-other-week for approximately four-five months. It is up to you and the team to decide what your meeting schedule should be.
- Calculate team expenses and consider how the team will pay those costs. Refer to Minnesota 4-H Financial practices.
- Using the SOAR rubric, review the components of the SOAR with parents and team members.
- Determine agricultural issue to address.
- Work through Science and Engineering Practices to develop a solution to the issue.

**SPRING/SUMMER:**

- 4-H teams share their presentation/demonstration at a local community forum.
- 4-H teams participate in the 4-H SOAR Challenge. The two-day event will include judging presentations and skill-based sessions for participants, a challenge fair to share their work with attendees, and an awards celebration recognizing the highest ranking teams. Activities and campus tours will also be developed for participants to connect them to agriculture and science resources at the University, and learn about possible areas of future study at the University of Minnesota.
- Make a plan to celebrate at the end of your season.

**YOUTH AND ADULT PARTNERSHIP**

**TEAM MEMBERS**

The Science of Agriculture Response team may include 3-4 youth, grades 6 and above. Team members do not have to be current 4-H members, but should be enrolled upon joining the team to be covered under 4-H accident insurance and receive full membership opportunities.

Limiting your team to four members may be difficult, but it provides the optimal small group experience. If you have more than four youth interested in joining the SOAR team, consider starting a second team or use a selection process to decide who may participate on your team.

**VOLUNTEER OPPORTUNITIES**

There are a number of important volunteer roles in the Science of Agriculture Response Challenge: Coach*, Coordinator*, Mentor, and Parent. Coaches, mentors, and parents help youth learn new skills or concepts that allow youth to solve the challenge.

*One person may serve as both the Coach and the Coordinator*
**Coach**

The role of a Coach is to inspire the team and help them get excited about the science of agriculture. Coaches give teams guidance and provide structure, encouragement, and most of all, a fun experience. They meet regularly with the team and guide them in developing goals and a timeline. The coach serves as the facilitator to help the team complete its work and improve the way team members work together. Coaches guide the process while the youth control the content.

Team members must make all decisions and do all the work. This includes deciding on the issue, researching, choosing an innovative solution, and presenting at the Challenge.

Does this mean you should stand idly by while your team struggles? Absolutely not! Instead of telling the team how to solve a problem, try asking questions like:

- What would happen if...?
- And then...?
- How will that affect...?

Young people become problem solvers by finding solutions themselves. We understand that adults can be just as passionate about SOAR as children, but adults must always remember that the young people come first.

**Coordinator**

The Coordinator serves as the liaison between team members, Coaches, Mentors, parents, other volunteers, and 4-H program staff. They work with the Coach to plan and schedule meetings, visits, and trips. The Coordinator ensures that policies and risk management requirements are followed, accurate financial records are kept, and teams are registered. They also ensure that volunteers and supporters are recognized.

**Mentor**

A mentor is any person who works with the team in his or her area of expertise for at least one team meeting, but the most effective mentor relationship is one that continues over time. Mentors help expose the team members to potential careers in addition to helping them learn the skills necessary to complete the SOAR Challenge. The most important quality for a mentor is someone who enjoys working with young people and wants them to learn.

When recruiting Mentors, consider their ability to work with the SOAR age group. They need to be role models and commit to the values of 4-H youth development. Talk to them about:

- Adapting their knowledge to an appropriate level for the team members;
- The team’s goals, the timeline, and structure of the meetings;
- Guiding the team to find the answers to their own questions; and
- The importance of acknowledging all team members, getting everyone to contribute and participate, providing positive feedback, and encouraging responses.

Potential sources for mentors might include:
Companies in your community. Many companies encourage their employees to volunteer, and some even have formal programs to match volunteers with groups in the community.

- Commodity or agricultural-oriented organizations. Think about Farm Bureau, Farmers Union, commodity groups, agricultural Chambers of Commerce, etc.

Parents and relatives of your team members

**Parents and Guardians**

Parents and guardians may assist the team by serving as a Coach, Coordinator, or Mentor if they have the skills, time and interest. They may plan fundraisers, provide a team meeting space, make travel arrangements or provide refreshments.

**THE CHALLENGE**

**SCIENCE AND ENGINEERING PRACTICES**

Teams will use the Eight Science and Engineering Practices\(^1\) as the framework to prepare for the SOAR Challenge. Teams will need to work through each step and be able to share how the practices were applied to finding a solution to the selected issue. The practices are as follows:

1. Asking questions (for science) and defining problems (for engineering);
2. Developing and using models;
3. Planning and carrying out investigations;
4. Analyzing and interpreting data;
5. Using mathematics and computational thinking;
6. Constructing explanations (for science) and designing solutions (for science);
7. Engaging in argument from evidence; and
8. Obtaining, evaluating, and communicating information.

The next section contains more information and examples of how the Eight Practices of Science and Engineering can be applied to the Science of Agriculture Challenge using the Case Example: The Decline of Pollinators. This case example was prepared by Patrick Jirik, University of Minnesota Extension Educator and is indicated by *italics*.

**Overview:** More than one third of the food we eat is directly dependent upon honey bees for pollination. Honey bees are a critical piece of the agricultural system worth more than $15 billion annually. Since 2006 bees and other pollinators are dying off at an alarming rate, raising concerns about the future of pollinators and the nation’s food supply.

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1. **Asking questions and defining problems.** Science begins with questions; engineering begins with defining a problem to solve. Asking questions and defining problems involves asking questions about data, claims that are made, proposed designs, and lead to additional practices or further analysis, interpretation, planning, investigation and design.

   *One of the questions to ask is “Why are honey bees and pollinators dying?” Youth could examine this question in more detail by studying the factors that are directly affecting the rapid decline of honey bees. Factors include: lack of pollinator habitat, bee diseases and parasites as well as widespread use of chemicals that are toxic to bees and pollinators. A new class of insecticides, based on synthetic nicotine and known as neonicotinoids is becoming the focus of intense controversy over their effect on bees and pollinators. Asking questions and defining problems leads to the development and use of models.*

2. **Developing and using models.** In science, models are used to represent systems (or parts of a system, to aid in the development of questions and explanations, to generate data that can be used to make predictions, and to communicate ideas to others. In engineering, models may be used to analyze a system to see where or under what conditions flaws might develop, or to test possible solutions to a problem. Models can also be used to visualize and refine a design, to communicate a design's features to others, and as prototypes for testing design performance.

   *Developing and using models allows for testing and possible problem solving to take place on a small scale. Test plots are a proven method of using models to study agronomy and horticulture crops on a small scale. In studying the causes that claimed to adversely affect pollinator health, one or more of the factors could be studied in much greater details by using small scale models and prototypes.*

3. **Planning and carrying out investigations.** Engineering investigations help find out how to fix or improve a system, or to compare different solutions to see which best solves a problem. Whether youth are doing science or engineering, it is always important to state the goal of an investigation, predict outcomes, and plan a course of action that will provide the best evidence to support their conclusions.

   *To successfully carry out an investigation the purpose or goal has to be clearly defined. A well thought out course of action with approved practices for collecting results will provides greater accuracy and useful data. Using the example of honey bees, an investigation of the varroa mite-(the parasite that lives off the bee’s blood) could be used to determine if bee hives that have a planned mite control method are healthier than hives that have no mite control at all.*

4. **Analyzing and interpreting data.** Youth are expected to expand their capabilities to use a range of tools and to improve their abilities to interpret data. When possible and feasible, youth should use digital tools to analyze and interpret data. Whether analyzing data for the purpose of science or engineering, it is important youth present data as evidence to support their conclusions.
The ability to use tools to analyze and interpret data is a basic component of carrying out science and engineering work. Using the example of the varroa mites in bees, a beekeeper will place a cup of rubbing alcohol in a jar along with ½ cup of honey bees. The mites are “washed off the bees” yielding a mite count method that is accurate, efficient and yields meaningful data.

5. **Using mathematics and computational thinking.** Youth are expected to use mathematics to represent physical variables and their relationships, to make quantitative predictions, to use tools for observing, measuring, recording, and processing data. Computational thinking involves strategies for organizing and searching data, creating sequences of steps called algorithms, and using and developing new simulations of natural and designed systems.

The old saying “If you can measure it, you can manage it” applies to using mathematics and computational thinking. It is one thing to have collected numbers. It is another thing to put the numbers to use and have meaningful results. In the example of studying varroa mites in honey bees, knowing the level of mite infestation and how it affects bee health is one of the predictors of the hives ability to survive over the winter.

6. **Constructing explanations and designing solutions.** The goal of science is to construct explanations for the causes of phenomena. Students construct their own explanations and apply standard explanations. The goal of engineering is to solve problems. Designing solutions to problems is a systematic process that involves defining the problem, then generating, testing and improving solutions.

This section of the eight practices focuses on defining the problem than testing to develop a solution(s). In the case of mite control a youth may learn that knowing the life cycle of varroa mites is beneficial when implementing a mite control method.

7. **Engaging in argument from evidence.** Reasoning and argument are needed to identify and agree about the best solution to a design problem. Whether investigating a phenomenon, testing a design, or constructing a model for an explanation, youth are expected to use argumentation to listen to, compare, and evaluate competing ideas and methods.

Engaging in argument from evidence can take place in several formats. Conversations, blogs and further research provide the opportunity to engage in argument. Look for experts in the field who have studied the topic and those who make their livelihood in the field. Engaging in arguments involves gathering information and viewpoints from a variety of sources, not only those who agree with the findings. For example, if a youth is convinced neonicotinoids insecticides are a major factor in the rapid decline of honey bees, information should not only be obtained from the Xerces Society website; the nonprofit organization dedicated to protecting pollinators. Information should also be obtained from the Bayer Crop Science website. Bayer Crop Science is a branch of the German pharmaceutical company that manufactures and markets neonicotinoids insecticides.

8. **Obtaining, evaluating, and communicating information.** Being able to read, interpret, and produce scientific and technical text are fundamental practices of science and engineering, as is the ability to communicate clearly and persuasively. Communicating
information, evidence, and ideas can be done using tables, diagrams, graphs, models, interactive displays, and equations as well as orally, in writing, and through extended discussions.

Obtaining, evaluating and communicating information can be carried out in a variety of ways. A written report in school and a presentation at a 4-H Club meeting each offer the opportunity to evaluate and communicate information. A three sided county fair exhibit and conference judging experience also provide youth with the opportunity to convey information and share findings. Youth who increase their technical knowledge, understanding and appreciation for a given subject are able to engage in meaningful communication and extended conversations. That fosters and supports a continued desire for self-directed learning.

IDENTIFY AN ISSUE

A central part of the Science of Agriculture Response Challenge will be the team’s focus on an ag-related issue in your community. Identifying an issue is an important step in your team’s process because it will shape your team’s research and solution. Consider these suggestions to engage youth in starting to define an agricultural issue:

• Conduct a survey of public officials and citizens (youth and adults)
• Visit with local agricultural businesspeople. Ask the owner/manager and employees what they see as needs in their business.
• Read local newspapers. Circle the agricultural issues. What stories leave you feeling disturbed or unsettled? What articles make you sad or ashamed? Select and cut out articles that address needs and issues that your team could address.

After asking questions and defining a problem, choose one that would be interesting to solve and that is feasible for your team. Then you’re ready to work your way through the remaining seven Science and Engineering Practices.

Here are some examples to get you thinking:

• Engage local agronomists to solve a weed issue using remote-control helicopters for weed scouting.
• Engage local wildlife experts to develop mitigation plans for invasive species in local lakes using aquatic robots.
• Engage a local agribusiness to develop business plans for community food gardens.
• Engage local civic leaders to develop ideas to keep rural communities vital and grow rural tourism.

JUDGING RUBRIC

Science of Agriculture Response Challenge is supported by a rubric, or worksheet, developed to help judges record their feedback. The rubric guides the judges through key criteria that reflect what is most important about the SOAR experience. Rubrics also create a consistent way to
differentiate between teams at different levels of achievement. Your team will be assessed as Beginning, Developing, Accomplished, or Exemplary in each category.

The rubric is divided into three categories:

**1. CORE VALUES**

**Motivation:**
1) Balanced emphasis on all three aspects (core values, project, presentation);
2) Application of SOAR values and skills outside of the Challenge; and
3) Imagination and curiosity drive project development.

**Teamwork:**
1) Problem solving and decision-making processes help team achieve goals;
2) Resources used relative to what the team accomplishes; and
3) Appropriate balance between team responsibility and coach guidance.

**Professionalism:**
1) Consideration and appreciation for the contributions of all members;
2) Team members act and speak with integrity; and
3) Team competes in the spirit of friendly competition and cooperates with others.

**2. PROJECT**

**Research:**
1) Clear definition of the problem being studied;
2) Evidence of partnership with one or more individuals in business related to issue;
3) Types and number of quality sources cited;
4) Depth to which the problem was studied and analyzed by the team; and
5) Extent to which existing solutions were analyzed, including an effort to verify originality of solution.

**Strategy and Innovation:**
1) Clear explanation of proposed solution;
2) Team developed a plan, produced and tested models, selected among alternative, and refined ideas;
3) Team’s solution makes life better;
4) Team tested their project; and
5) Consideration of factors for implementation.

3. PRESENTATION

Group presentation:

1) Team shared their project before the event;
2) Imagination used to develop and deliver presentation; and
3) Message delivery and organization of the presentation.

Presentation/Demonstration Format

Teams need to put a presentation/demonstration together that tells the judges what their problem was and how they utilized the 8 steps in the science and engineering process to address and/or solve their local agricultural issue.

Teams will be assigned a 30 minute time slot for the day(s) of the Challenge Event:

- 20 minutes for presentation/demonstration where all members of team actively participate.
- 10 minutes for interaction and questions with the judge(s).
- Teams may use visuals that enhance the presentation. These may include posters, objects, models, costumes, slideshows, handouts, PowerPoint presentations and more as long as they are considered safe and not considered dangerous. (If you require clarification or are not sure if your required material is appropriate please contact the Science of Agriculture Extension Specialist.)
- Special audio or visual materials need to be identified and shared with the Science of Agriculture Extension Specialist prior to the destination event (LCD screen, laptop, projector, etc.).

Other Requirements

- Live animals are not permitted.
- All presentations should promote or identify 4-H in some way, such as on posters, flags, tablecloth, or mentioned in oral presentation.
- Please note that, while youth may have assistance from other 4-H youth, parents and other adults, they are not allowed to help in any way during the presentation/demonstration. Points will be deducted from the overall score if there is adult participation in a presentation.

AWARDS

Top teams will be recognized. Individuals on the first place team will each receive a $1,000 scholarship; second place team members will each receive $750 scholarships; and third place team members will receive $500 scholarships.
**REFLECT ON AND CELEBRATE THE SEASON**

Reflection is an essential element of the Experiential Learning Process and should happen throughout the season. Ideas for reflection can be found at [http://www.extension.umn.edu/youth/mn4-H/leading-a-club/](http://www.extension.umn.edu/youth/mn4-H/leading-a-club/)

Acknowledging and celebrating your team's accomplishments, both individual and collective, is essential. Even if the team didn't reach all its goals, they have accomplished a lot and the members should be proud. Also remember to recognize the contributions of Mentors, Sponsors, Volunteers, and your host site.

**FUNDING A SOAR TEAM**

Some resources will be needed to support a SOAR team. Consider the following as you start to build a budget:

- $X = $ materials for project
- $X = bus/van to take team to Challenge event at the University of Minnesota
- $X = Challenge Lodging costs for team
- $X = Challenge Event Meal costs for team
- $100 = Team Challenge Registration

Sources of funding may include local agricultural businesses, commodity groups, County 4-H Federation/Leaders' Council, etc.

For more information on financial practices and policies in Minnesota 4-H, go to [http://www.extension.umn.edu/youth/mn4-H/leading-a-club/](http://www.extension.umn.edu/youth/mn4-H/leading-a-club/) and look for “Money Matters.”

**TIPS FOR BEGINNING SOAR TEAMS**

*From FIRST Lego League Team - The Inventioneers, NH, U.S.*

1. Remember, you don’t have to be an engineer to be a great SOAR Coach.

2. Work with team members to come up with goals and rules for your team at the first meeting. A few examples:
   - Respect others’ ideas.
   - Help others. If a team member is an expert in robot-building, she should be willing to help teach others this skill.
   - Identify ways to encourage each other.
   - It’s everybody's job to make sure the whole team participates.

3. Set aside time at the beginning of the first few meetings to learn about each other.

4. Get the team committed to a meeting schedule before the season starts. Members who can't attend meetings make it hard for the whole team.
6. Make sure all parents have roles – even rotating ones (Assistant Coach, snack provider, fundraising lead, photographer) so that they become invested in the progress of your team.

7. Use good time management. Put Challenge Event on the calendar as soon as the dates are released. Keep the kids focused on how much time they have to accomplish tasks. This way, everything doesn't pile up just before the Event.

8. Keep it FUN!!! The kids will learn to handle frustrations and deadlines better if the element of fun is in the mix. Coaches and parents will be less tempted to “help” too much if there is an atmosphere that emphasizes the joy of learning and exploring new ideas.

**AVAILABLE SUPPORT**
University of Minnesota Extension is committed to your success and will provide the following support:

- This Quick Start Guide
- Monthly coach conversations
- Volunteer training on learning environments, welcoming environments, and other positive youth development topics
- Access to content experts
- Training on Eight Science and Engineering Practices

**ACKNOWLEDGEMENTS**
Minnesota 4-H would like to thank FIRST® and the FIRST® LEGO® League (FLL®) for the use of their program judging rubrics as a basis for the Science of Agriculture Program. FIRST® is a New Hampshire 501(c)3 not-for-profit public charity that designs accessible, innovative programs that motivate young people (6-18 years) to pursue education and career opportunities in science, technology, engineering, and math, while building self-confidence, knowledge, and life skills. National 4-H is a current FIRST® Strategic Partner with a shared vision of promoting STEM skills and future workforce development. For more information on FIRST® programs visit www.usfirst.org

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*Case Example: The Decline of Pollinators*, prepared by Patrick Jirik, Extension Educator

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Updated September 2014

Updated May 2017