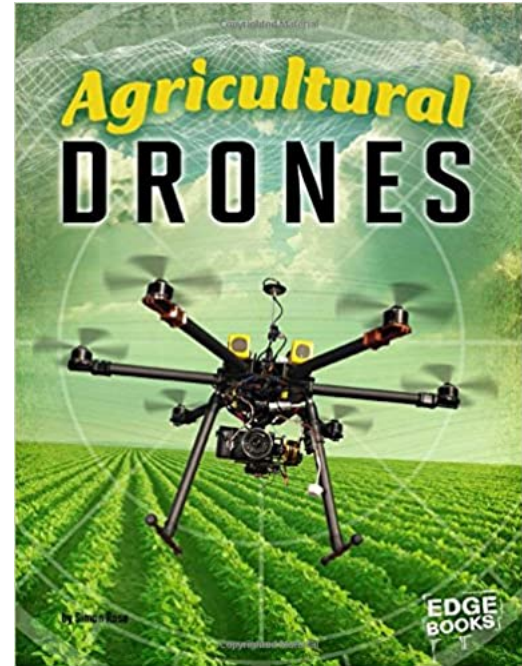


**May 2020 Book of the Month**  
*Agricultural Drones*  
**By: Simon Rose**

Farm fields can span hundreds of acres. With so much area to cover, checking crops and livestock can be difficult. But with an agricultural drone, this job becomes much simpler. Readers will discover how drones help farmers maximize efficiencies and bring abundant harvest.<sup>1</sup> This book also takes the reader through the many concepts of agricultural drones, including how they help farmers solve problems, the different types of drones, their parts and features, and what drone technology could mean to future generations of farmers and cultures.



### Fun Facts

- Drones that fly are also called unmanned aerial vehicles (UAVs).<sup>1</sup>
- According to the Federal Aviation Administration rules, drones must operate in daylight. They can operate during twilight only if the drone has anti-collision lights.<sup>1</sup>
- Drones have been used for sheep herding purposes before, much like a farmer would use a herding dog, and also as scarecrows to ward off pests.<sup>1</sup>
- The eBee agricultural drone's motor is started by the operator shaking it three times and then throwing it in the air!<sup>1</sup>
- Some researchers are building agricultural drones with robotic arms. These drones could someday pick pests off plants.<sup>1</sup>
- Farmers in North Carolina can use agricultural drones to assess hurricane damage on their crops and flooding in fields.<sup>2</sup>

### Vocabulary from the book<sup>1</sup>

**3-D:** having or appearing to have length, depth, and height.

**Carbon fiber:** a strong, lightweight material made with acrylic fiber using high temperatures.

**Chlorophyll:** the green substance in plants that uses light to make food from carbon dioxide and water.

**Dehydrated:** not having enough water.

**Download:** to move or copy data from an electronic device or website to another electronic device.

**Global Positioning System (GPS):** an electronic tool used to find the location of an object; this system uses signals from satellites.

**Hydrogen:** a colorless gas that is lighter than air and burns easily.

**Maneuverable:** able to move and control easily.

**Navigation system:** equipment that allows a vehicle to follow a course from one place to another.

**Near-infrared:** related to short wavelengths of radiation that are not visible to people.

**Remote control:** a device used to control machines from a distance.

**Resolution:** describes a device's ability to show an image clearly and with a lot of detail; low-resolution images don't show as much detail as high-resolution images.

**Rotor:** a set of rotating blades that lifts an aircraft off the ground.

**Satellite:** a spacecraft used to send signals and information from one place to another.

**Survey:** to look over and study closely.

**Thermal:** having to do with heat or holding in heat.

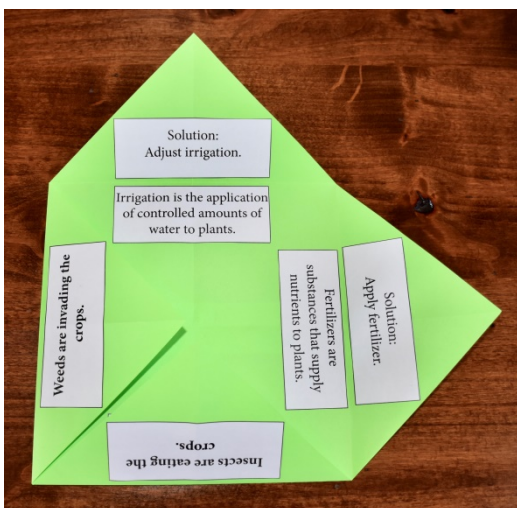
### **Discussion Questions:**<sup>3</sup>

After reading the book, *Agricultural Drones*, ask students to answer the following questions in their journals (or you may choose to start a class discussion). The answer key is below in the **Links** section.

1. How are agricultural drones similar to other drones?
2. How are agricultural drones different from other drones?
3. How are drones used by crop farmers?
4. How are drones used by livestock farmers?
5. What are the advantages of using drones on farms?
6. What are the benefits of gathering images from a drone instead of a satellite?
7. Who sets the rules for drone use in the United States?
8. Name three rules for drone use in the United States.
9. What are two ways that a drone can be flown?
10. Describe the differences between fixed-wing drones and rotor drones.
11. Describe the three different types of camera typically carried by agricultural drones.
12. Name two things that can be measured by drone sensors.
13. What are drone bodies made of?
14. How are drone motors powered?
15. What does GPS stand for and how does it work?
16. Which type of business is most likely to use drones?
17. What are two reasons for the increased use of drones?
18. What is the predicted world population in 2050?
19. Because people need to eat, a population increase means more \_\_\_\_\_ will need to be produced.
20. In what type of counties is the population expected to increase the most by 2050?
21. Which continent has the largest number of least developed countries?
22. Why do governments make laws about drone use?

## Crop Troubleshooting<sup>3</sup>

1. After the discussion questions have been completed, lead a class discussion about general crop problems. Integrate the following points into the discussion.
  - When insect pests eat crops, the plants do not thrive. Pesticides are substances used to destroy harmful insects.
  - When weeds invade crops, they compete with plants for water, nutrients, and sunlight. Herbicides are substances used to destroy weeds.
  - When plants do not receive enough water, they wilt and eventually die. Irrigation is the application of controlled amounts of water applied to plants.
  - When plants do not receive proper nutrients, they grow slowly and turn yellow. Fertilizers are substances that supply nutrients to plants.
  - Pesticides, herbicides, and fertilizers can be part of either organic or conventional farming practices, depending on the specific types that are being used.
2. Have students capture the discussion information by creating a “Crop Troubleshooting Guide.” Provide each student with a blank 8 ½” x 11” piece of paper. Fold the paper so that the top edge meets the left edge and forms a point at the top left corner. Cut off the excess paper strip at the bottom. Open the paper to make a square and then refold it the opposite way. Open the fold to reveal an X fold pattern. Fold each corner to the center point of the X to form a small square. Turn the square over and write the title “Crop Troubleshooting Guide” and your name. Turn the guide back over to the side with the four tabs.
3. Provide each student with a copy of the Crop Troubleshooting Cards (see **Links**, and attached to this activity sheet). Instruct the students to cut out the cards. Have the students use their glue sticks to attach the title card “Crop Troubleshooting Guide” to the back of the square (the side without the tabs). Ask the students to match each of the four problem cards (bold font) with the corresponding solution card and the solution description card. Glue the problem cards on the outside of each tab, the solution cards on the inside of the tabs, and the solution description cards underneath the tabs so that the following information is captured:



- **Outside tab 1:** Insects are eating the crops.  
**Inside tab 1:** Apply pesticides.  
**Underneath tab 1:** Pesticides are substances used to destroy harmful insects.
- **Outside tab 2:** Weeds are invading the crops.  
**Inside tab 2:** Apply herbicides.  
**Underneath tab 2:** Herbicides are substances used to destroy weeds.
- **Outside tab 3:** The crops are wilting.  
**Inside tab 3:** Adjust irrigation.

**Underneath tab 3:** Irrigation is the application of controlled amounts of water applied to plants.

- **Outside tab 4:** The crops are growing slowly and turning yellow.

**Inside tab 4:** Apply fertilizer.

**Underneath tab 4:** Fertilizers are substances that supply nutrients to plants.

### How Does a Drone Fly?<sup>3</sup>

1. Ask the students, “How do drones fly?” After listening to their responses, lead a discussion about gravity and lift. Integrate the following points into the discussion:
  - a. Gravity is the natural force that causes things to fall toward the Earth.
  - b. Lift is the force that directly opposes the weight of the aircraft and holds the aircraft in the air.
  - c. Quadcopter drones use rotors to help the drone lift off the ground and fly.
  - d. As the rotor pushes down on the air, air pushes up on the rotor.
  - e. In order for the drone to fly into the air, a force that equals or exceeds the force of gravity must be created. This is called lift.
  - f. The faster the rotors spin, the greater the lift.
2. Turn on a hair dryer and aim it toward the ceiling. Place a ping pong ball into the stream of air. Ask the students, “Why is the ping pong ball floating?” (The force of the air pushing up on the ball is equal to the force of gravity pushing down on the ball, so the ball is hovering in the air.)
3. Ask the students what they think will happen to the ping pong ball if the hair dryer is turned off. Turn the hair dryer off to show the students that the ball will fall to the ground. Ask the students, “Why does the ping pong ball fall when the hair dryer is turned off?” (The force of the air pushing up on the ball is less than the force of gravity pushing down on the ball.)
4. Hand out two 2”x6” pieces of paper and a paper clip to each student. Instruct the students to crumple one of the pieces of paper into a ball. Use the following to make a rotor with the other piece of paper.
  - a. Hold the paper so that the 2” edges are at the top and bottom.
  - b. Fold the paper in half vertically.
  - c. Unfold the paper, and draw a horizontal line 2” from the top and a horizontal line 3” from the bottom.
  - d. From the top, cut down the middle fold to the 2” line. Fold one of the flaps forward and the other flap backward on the line to make the rotor’s blades.
  - e. On the other line, make a mark 5/8” from the right. Make a cut along the line from the right





- stopping at the 5/8" mark.
- f. On the same line, make a mark 5/8" from the left. Make a cut along the line from the left stopping at the 5/8" mark.
  - g. Draw a line from each 5/8" mark to the bottom of the paper. Fold the paper into the middle along each of these lines.
  - h. Draw a horizontal line 1" from the bottom. Fold the paper along this line and place a paper clip on the fold.
5. Have students carefully stand on their chairs and drop their crumpled ball and their rotor (paper clip facing down) at the same time from the same height.
  6. Ask the students, "Which stayed in the air the longest, the crumpled ball or the rotor? (the rotor) "Why did the rotor stay in the air longer?" (The design of the rotor causes the blades to spin as it falls through the air. The spinning blades generate enough lift to slow the rotor down.)
  7. Note to students that quadcopter drones' rotors are powered by motors that can create and maintain a force that is equal to or greater than the force of gravity. The rotors help the drone lift off the ground and fly.

### **Drones in Agriculture<sup>4</sup>**

Learn how researchers and farmers are using drones to help discern the future of agriculture. In this [video](#) (see **Links**) from *SciTech Now*, hear from farmers who are embracing new technologies to increase crop yields while decreasing over-fertilization and water waste. It's estimated that 90% of all drone use by the year 2025 will be in agriculture.

Smart advancements in agricultural technology could be the key to increasing farmers' profitability, decreasing the environmental impact, and increasing food production to support an ever-growing global population.

#### Video Discussion Questions:

1. What are some of the reasons Jeff Sandborn gives for embracing agricultural technology?
2. According to Bruno Basso, why is a uniform application of fertilizer a waste?
3. How do drones help farmers use fertilizer more efficiently? What is the outcome for farmers who use the drone?
4. How does the software Bruno Basso is developing help farmers?

#### Engineering Questions:

1. How can technology impact agriculture?
2. How can technology impact land usage?
3. As technology advances, how do farmers react to keep up with these advancements?

### **Links**

- Drones: Their Powerful Role in Agriculture (article)  
<https://ipm.ces.ncsu.edu/2018/10/drones-their-powerful-role-in-agriculture/>
- Drones in Agriculture (video)

<https://unctv.pbslearningmedia.org/resource/stn15.sci.eng.drones/drones-in-agriculture/>

- How Do Drones Fly? (video)  
<https://www.youtube.com/watch?v=6Bc2nuOuRjM>
- Crop Troubleshooting Cards  
[https://naitc-api.usu.edu/media/uploads/2019/01/28/Crop\\_Troubleshooting\\_Cards.pdf](https://naitc-api.usu.edu/media/uploads/2019/01/28/Crop_Troubleshooting_Cards.pdf)
- Agricultural Drones Discussion Questions Answer Key  
[https://naitc-api.usu.edu/media/uploads/2018/10/24/Agricultural\\_Drones\\_Discussion\\_Guide\\_Answer\\_Key\\_1.pdf](https://naitc-api.usu.edu/media/uploads/2018/10/24/Agricultural_Drones_Discussion_Guide_Answer_Key_1.pdf)

#### Sources

1. Rose, Simon. *Agricultural Drones*. Minnesota: Capstone Press, 2017. Print.
2. <https://www.precisionag.com/in-field-technologies/drones-uavs/precision-agriculture-takes-flight-at-north-carolina-state/>
3. <https://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=688>
4. <https://unctv.pbslearningmedia.org/resource/stn15.sci.eng.drones/drones-in-agriculture/>

#### K-5 Subject Areas

Reading, Writing, Speaking and Listening, Science, and Social Studies

#### Common Core/Essential Standards

##### Reading

- **RL.K.1** With prompting and support, ask and answer questions about key details in a text.
- **RL.1.1** Ask and answer questions about key details in a text.
- **RL.1.2** Retell stories, including key details, and demonstrate understanding of their central message or lesson
- **RL.2.1** Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
- **RL.3.1** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the **basis for** the answers.
- **RL.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
- **RL.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.
- **RI.K.1** With prompting and support, ask and answer questions about key details in a text.
- **RI.K.2** With prompting and support, identify the main topic and retell key details of a text.
- **RI.1.1** Ask and answer questions about key details in a text.
- **RI.2.1** Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
- **RI.3.1** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
- **RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
- **RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

##### Writing

- **W.K.5** Participate in shared investigation of grade appropriate topics and writing projects.
- **W.K.6** With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- **W.1.5** Participate in shared research and writing projects.
- **W.1.6** With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- **W.2.5** Participate in shared research and writing projects.

- **W.2.6** Recall information from experiences or gather information from provided sources to answer a question.
- **W.3.5** Conduct short research projects that build knowledge about a topic.
- **W.3.6** Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.
- **W.4.5** Conduct short research projects that build knowledge through investigation of different aspects of a topic.
- **W.4.6** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
- **W.5.5** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
- **W.5.6** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work and provide a list of sources.

### **Speaking and Listening**

- **SL.K.2** Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.
- **SL.K.3** Ask and answer questions in order to seek help, get information, or clarify something that is not understood.
- **SL.K.4** Speak audibly and express thoughts, feelings, and ideas clearly.
- **SL.1.2** Ask and answer questions about key details in a text read aloud or information presented orally or through other media.
- **SL.1.3** Ask and answer questions about what a speaker says in order to gather additional information or clarify something that is not understood.
- **SL.1.4** Produce complete sentences to describe people, places, things, and events with relevant details, expressing ideas and feelings clearly.
- **SL.2.2** Recount or describe key ideas or details from a text read aloud or information presented orally or through other media.
- **SL.2.3** Ask and answer questions about what a speaker says in order to clarify comprehension, gather additional information, or deepen understanding of a topic or issue.
- **SL.2.4** Tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking
- **SL.3.2** Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
- **SL.3.3** Ask and answer questions about information from a speaker, offering appropriate elaboration and detail audibly in coherent and complete sentences.
- **SL.3.4** Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly in complete sentences at an understandable pace.
- **SL.4.2** Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
- **SL.4.3** Identify the reasons and evidence a speaker provides to support particular points.
- **SL.4.4** Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; adjust speech as appropriate to formal and informal discourse.
- **SL.5.2** Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
- **SL.5.3** Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence
- **SL.5.4** Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; adapt speech to a variety of contexts and tasks.

### **Science**

- **K.P.1.2** Give examples of different ways objects and organisms move (to include falling to the ground when dropped ): straight, zigzag, round and round, back and forth, fast and slow.
- **1.P.1.1** Explain the importance of a push or pull to changing the motion of an object.
- **1.P.1.3** Predict the effect of a given force on the motion of an object, including balanced forces.

- **3.P.1.1** Infer changes in speed or direction resulting from forces acting on an object.
- **3.P.1.2** Compare the relative speeds (faster or slower) of objects that travel the same distance in different amounts of time.
- **3.P.1.3** Explain the effects of earth's gravity on the motion of any object on or near the earth.
- **5.P.1.1** Explain how factors such as gravity, friction, and change in mass affect the motion of objects.
- **5.P.1.2** Infer the motion of objects in terms of how far they travel in a certain amount of time and the direction in which they travel.
- **5.P.1.4** Predict the effect of a given force or a change in mass on the motion of an object.

**Social Studies**

- **1.G.1.1** Use geographic tools to identify characteristics of various landforms and bodies of water.
- **4.G.1.4** Explain the impact of technology (communication, transportation and inventions) on North Carolina's citizens, past and present.



# Crop Troubleshooting Guide

**Insects are eating the crops.**

**Weeds are invading the crops.**

**The crops are wilting.**

**The crops are growing slowly and turning yellow.**

**Solution:  
Apply fertilizer.**

**Solution:  
Apply pesticides.**

**Solution:  
Apply herbicides.**

**Solution:  
Adjust irrigation.**

**Irrigation is the application of controlled amounts of water to plants.**

**Pesticides are substances used to destroy harmful insects.**

**Fertilizers are substances that supply nutrients to plants.**

**Herbicides are substances used to destroy weeds.**