

Journey 2050 Lesson 7: Technology and Innovations (Grades 9-12)

Grade Levels

9 - 12

Purpose

Students will explore new technologies that will impact the future of farming, understand the role of developing countries in food security, and explain how consumers influence the production of food.

Estimated Time

1 hour

Materials Needed

Interest Approach — Engagement:

- *Technology and Innovation* PowerPoint
- TED Talk, [A Global Food Crisis May be Less Than a Decade Away](https://www.ted.com/talks/sara_menker_a_global_food_crisis_may_be_less_than_a_decade_away) (https://www.ted.com/talks/sara_menker_a_global_food_crisis_may_be_less_than_a_decade_away?referrer=playlist-what_s_the_future_of_food#t-10251) by Sara Menker

Activity 1: Technology and Innovation

- *Technology and Innovation* PowerPoint
- *Future of Agriculture: Technology and Innovation* Handout, 1 technology sheet per group
- [Journey 2050 Technology & Innovation](https://www.youtube.com/watch?v=qexChWNFY5E&feature=youtu.be) (https://www.youtube.com/watch?v=qexChWNFY5E&feature=youtu.be) video
 - Based on [The Future of Farming & Agriculture](https://www.youtube.com/watch?v=Qmla9NLFBvU) (https://www.youtube.com/watch?v=Qmla9NLFBvU) video

Activity 2: Developing Nations

- *Technology and Innovation* PowerPoint
- TED Talk, [A Global Food Crisis May be Less Than a Decade Away](https://www.ted.com/talks/sara_menker_a_global_food_crisis_may_be_less_than_a_decade_away) (https://www.ted.com/talks/sara_menker_a_global_food_crisis_may_be_less_than_a_decade_away?referrer=playlist-what_s_the_future_of_food#t-218964) by Sara Menker

Activity 3: Impact of Consumer Choices

- *Technology and Innovation* PowerPoint
- [SnapAG Information Sheets](https://aitc-canada.ca/en-ca/learn-about-agriculture) (https://aitc-canada.ca/en-ca/learn-about-agriculture)

Essential Files (maps, charts, pictures, or documents)

- [Future of Agriculture: Technology and Innovation Handout](https://cdn.agclassroom.org/media/uploads/2019/07/18/Future_of_Agriculture_-_Technology__Innovation_1.pdf) (https://cdn.agclassroom.org/media/uploads/2019/07/18/Future_of_Agriculture_-_Technology__Innovation_1.pdf)
- [Technology and Innovation PowerPoint](https://cdn.agclassroom.org/media/uploads/2019/08/13/7-J2050_Lesson_7_1.pptx) (https://cdn.agclassroom.org/media/uploads/2019/08/13/7-J2050_Lesson_7_1.pptx)
- [Technology and Innovation: Find Someone Who Handout \(Enriching Activity\)](https://cdn.agclassroom.org/media/uploads/2019/07/18/7-J2050-Find_Someone_Who_1.pdf) (https://cdn.agclassroom.org/media/uploads/2019/07/18/7-J2050-Find_Someone_Who_1.pdf)

Vocabulary Words

innovation: a new method, idea, or product

technology: the application of scientific knowledge for practical purposes, especially in industry

Did You Know? (Ag Facts)

- In 1850, 100 bushels of corn required 83 labor hours and 2.5 acres of land. Today, only two labor hours and 0.6 of an acre of land are needed.²
- A modern combine can harvest 350 acres of corn per day (4,500 bushels per hour) and it can unload 3.8 bushels per second.
- If the world's farmers would have continued to grow crops at 1961 productivity levels, they would need almost 2.5 billion acres of new farmland to maintain today's food supply, which is more than the total land area of the United States.³
- The Association for Unmanned Vehicle Systems International predicts farms will eventually account for 80 percent of the commercial drone market.⁴

Background Agricultural Connections

Journey 2050 takes students on a virtual simulation that explores world food sustainability and answers the question, "How will we sustainably feed nearly 10 billion people by the year 2050?" The lesson plans and online simulation program allows students to make decisions on a virtual farm and witness their impact on society, the environment and the economy at a local and global scale. The lessons engage students with the important concepts regarding sustainable agriculture. The online simulation contextualizes these concepts as students experience the lives of three farm families in Kenya, India and Canada. As students interact with each family, they learn the role of best management practices in feeding the world, reducing environmental impact and improving social performance through greater access to education, medical care and community infrastructure. These lessons can be taught individually or as an entire unit. See the links below for the remaining lessons:



- [Lesson 1: Introduction to Sustainable Agriculture](https://agclassroom.org/matrix/lesson/582/) (https://agclassroom.org/matrix/lesson/582/)
- [Lesson 2: Plant Health](https://agclassroom.org/matrix/lesson/583/) (https://agclassroom.org/matrix/lesson/583/)
- [Lesson 3: Water](https://agclassroom.org/matrix/lesson/584/) (https://agclassroom.org/matrix/lesson/584/)
- [Lesson 4: Economy](https://agclassroom.org/matrix/lesson/586/) (https://agclassroom.org/matrix/lesson/586/)
- [Lesson 5: Land Use](https://agclassroom.org/matrix/lesson/587/) (https://agclassroom.org/matrix/lesson/587/)
- [Lesson 6: Careers for 2050 and Beyond](https://agclassroom.org/matrix/lesson/588/) (https://agclassroom.org/matrix/lesson/588/)
- Lesson 7: Technology and Innovations
- [Take Action: Project-based Learning and Program Summary](https://www.agclassroom.orghttps://agclassroom.org/matrix/resource/765/) (https://www.agclassroom.orghttps://agclassroom.org/matrix/resource/765/)

Life on the farm 100 years ago looked vastly different compared to today, and it will continue to change to meet the needs of the world. Cutting-edge **technology** and **innovations** are being used in agriculture. These new technologies are being developed with a purpose to overcome the challenges we face in providing food, fuel, and fiber for a growing population.

The use of technology can be found in nearly every aspect of our daily lives and has revolutionized farming with more innovations on the horizon! Some technologies are emerging while others have been adopted globally.

Here are a few examples. Have you seen any of these innovations in action?

Autonomous robots

Agriculture requires a significant amount of manual labor. What do you think a robot can do on a farm? Autonomous pickers identify and pick ripe fruits and vegetables. Other specialized robots find and eliminate weeds and pests that damage crops.

Agriculture sensors

Precise timing is key! When it comes to nutrient management, watering, pest management, and harvest, too early or too late doesn't cut it. High-tech sensors located in fields send alerts to farmers through an app on their phone when it's time to take action.

Aerial crop imaging

Arable land suitable to produce our food is a limited

resource. Aerial images taken with drones, satellites, and planes can help farmers map their fields and use the land to its greatest potential. Drones can perform crop monitoring, planting, and even spraying tasks.

Agriculture data systems

Record keeping and data collection helps farmers identify successful solutions and areas that need improvement. Notebooks are being replaced with digital platforms. Farm data, such as annual crop yield, market forecasts, soil nutrients and weather, are collected and stored electronically to give farmers valuable information as they make decisions.

Global Positioning Systems (GPS)

GPS-based applications are being used for farm planning, field mapping, and more! The farmer is always present, but one of the most popular features of GPS is that the tractor can drive itself to ensure perfect rows and the farmer can program precise applications of seeds and fertilizer.

Vertical and indoor farming

Growing crops up, instead of out! Now that's a good idea! Vegetables and fruits tend to work best in vertical farming, but who knows what the future will hold? Vertical farming is ideal where land isn't available and it can even be used as a way to repurpose abandoned structures.

Livestock health and activity monitors

The livestock industry utilizes technology in a variety of ways to ensure animal health, safety, and welfare. For example, "smart collars" are used like a personal fit bit, tracking daily activity, behavior, and health. Breath analysis can be achieved with high-tech equipment allowing farmers to evaluate potential health problems and diet. Thermal imaging and 3D cameras have the capability of analyzing an animal's body muscle and weight to advise farmers when to sell their livestock.

Fish farms and aquaponics

Specialized fish farms involve raising fish in tanks or enclosed ponds. Aquaponic systems are a unique way to grow fish and plants symbiotically. By using a zero-waste system, waste from the fish is cycled through the system serving as a source of nutrients to grow the plants.

Insect protein

Meat, milk, and eggs are common sources of protein in our diet. But, what about bugs as a source of protein? Insects are affordable and require fewer natural resources. Known as entomophagy, the eggs, larvae, pupae, and adults of certain insects are eaten as part of a meal.

Cultured meats

Another alternative protein source is cultured meat. It isn't "meat" in the traditional sense as it doesn't come from processing an animal. It is formed in a lab using animal cells. Cultured meat uses techniques to engineer tissues to form a meat alternative.

New seed varieties

Genetically modified organisms (GMOs) and CRISPR technologies edit genes in plants to overcome a challenge, such as a disease. A lot of time and money is required to produce a GMO plant. It takes approximately 13 years to research and ensure its safety and can cost around \$136 million dollars.¹

After looking at these emerging technologies, it's easy to see that farms of the future may look very different than they do today. Will these technologies and more answer the question, "How will we sustainably feed nearly 10 billion people by the year 2050? Surely it will make a difference, but each innovation must be understood for the benefits and limitations it brings. There is no one-size fits all agricultural solution to address the different needs of a growing population.

Consider robotics. Many fruit and vegetable crops are still highly dependent upon manual labor. Technologies such as robotic harvesting machines could decrease the demand and production cost for human laborers. However, even the most sophisticated technology may not compare to the efficiency and precision of human laborers to harvest fruits and vegetables at the precise time and maturity and in a way that does not bruise or damage the produce. The road ahead includes significant amounts of research and financial investment to engineer robots to work on large-scale farming operations. Some robots will need to work on thousands of acres in varying terrains and with varying crops. Others may be needed to perform delicate and timely harvesting.

What about vertical farms? They seem like an easy solution to save land, but are they a solution for all crops? Microgreens, like herbs and vegetables such as lettuce, seem to have the most success and may be grown with less water and crop inputs; however, the high energy cost to provide artificial lighting and adequate growing temperatures for the plants must be decreased for vertical farming to be economical. Not all crops can be grown with the methods used in vertical buildings.

Innovative technologies will be part of the solution to meet the needs of a growing population, but there are complex structural and environmental challenges that will need to be addressed. What technologies can be implemented in developing nations to secure a more sustainable food supply? How do consumer food choices impact the sustainability of our food supply? How can we use the United Nations Sustainable Development Goals to alleviate sudden disruptions in the food supply and famine? Most importantly, what can each of us do to be part of the solution today?

We have a lot of challenging problems that require critical thinking and creative solutions to sustainably increase our food supply for a growing population. New solutions are being researched and tested each day to solve this global challenge.

What ideas do you have to help feed the world?

Interest Approach - Engagement

This lesson has been adapted for online instruction and can be found on the [Journey 2050 eLearning site](https://agclassroom.org/eLearning/journey/) (<https://agclassroom.org/eLearning/journey/>).

1. *Technology and Innovation* PowerPoint Slide 2: Show students the TED Talk, [A Global Food Crisis May be Less Than a Decade Away](https://youtu.be/OzA6jRYjVQs) (<https://youtu.be/OzA6jRYjVQs>) by Sara Menker.

2. Pause the talk at 2:29 (15:04 remaining) and discuss Sara's statement, "We could have a tipping point in global food and agriculture if surging demand surpasses the agricultural system's structural capacity to produce food." Discuss the concepts of supply and demand as well as a "capacity" to produce food. As demand (population) rises, what limits our capacity to produce food? (*arable land, water, soil nutrients, etc.*)
3. Next ask, "What are some things that can increase our capacity to produce food?" Allow students to brainstorm their own ideas.
4. Explain to the students that they will be exploring three ways to expand our capacity to produce food:

- Developing and implementing new technologies,
- Helping developing countries improve farming efficiency, and
- Learning how consumer choices can either support or challenge food sustainability.

Procedures

Preparation: Prior to class, review the *Background Agricultural Connections*, video clip, and lesson procedures associated with the lesson. Review the [Teacher's Guide: Getting Started](https://cdn.agclassroom.org/media/uploads/2019/08/12/0-J2050_Getting_Started.pdf) (https://cdn.agclassroom.org/media/uploads/2019/08/12/0-J2050_Getting_Started.pdf) document for further information to prepare for class.



Activity 1: Technology and Innovation

1. Explain that our ultimate goal is to produce a sustainable food supply for the growing population. Along the path to the year 2050, there are many obstacles and challenges to overcome. Define the word *innovation* and explain that new technologies help overcome challenges in agriculture.
2. Prepare students for the video clip by letting them know that they will be introduced to several innovations that can be used in agriculture. As they watch, they should also consider the challenge(s) that each innovation could help to overcome.
3. *Technology and Innovation* PowerPoint Slide 3: Play the [Journey 2050 Technology & Innovation](https://youtu.be/qexChWNFY5E) (<https://youtu.be/qexChWNFY5E>) video.
 - Please note the above video was based on [The Future of Farming & Agriculture](https://www.youtube.com/watch?v=Qmla9NLFBvU) (<https://www.youtube.com/watch?v=Qmla9NLFBvU>) video. The views shared in this video do not necessarily reflect those shared by Journey 2050.
4. Slide 4: After the video, have students share their thoughts. Ask questions such as, "Which innovation do you think could be most impactful and why?" or, "What are some pros and cons of using these technologies?"
5. Slide 5: Give each pair (or small group) of students one copy of the *Future of Agriculture: Technology and Innovation* handout.
 - **Note:** You should have one copy (printed single-sided) of this PDF per group. The sheet they receive represents the specific technology they will be researching. There are three blank sheets at the end of the document, if your students would like to research an innovation not currently on the list.
6. Provide time for the students to perform research and create a digital presentation about their technology to share with the class. Students should use the four sections found on their handout to outline their research and presentation:

- **Describe it.** Students should describe the technology, how it is used, where it is used, etc. If possible, include details such as how much it costs and where it is currently being used in agriculture today.
 - **What are the benefits?** What obstacle(s) does this innovation overcome?
 - **What are the limitations?** Each form of technology has limitations. What are they? Is it the expense of the equipment, accuracy of its use, etc.?
 - **See it in Action!** Have students find images or a demonstration video of the technology in action.
7. Slide 6: As each team presents to the class, have the class consider what changes in society, environment, or economy would have to be made for the innovation to be adopted globally.
 8. As a class or as an individual assignment, have students select what they believe are the three most promising innovations that will make a difference in the future of agriculture. Remind students to focus on the goal of providing a sustainable food supply for a growing population.

Activity 2: Developing Nations

1. *Technology and Innovation* PowerPoint Slide 7: Discuss, compare, and contrast the terms "developing" nation and "developed" nation with your students. Help students recognize the meaning of these terms in the context of various topics such as economics (access to capital and markets), health, safety and sanitation, educational opportunities, etc.
2. Slide 8: Once students have a foundational knowledge of developing nations, have students watch the remaining portion of the [TED talk](https://www.ted.com/talks/sara_menker_a_global_food_crisis_may_be_only_a_decade_away?referrer=playlist-what_s_the_future_of_food#t-218964) (https://www.ted.com/talks/sara_menker_a_global_food_crisis_may_be_only_a_decade_away?referrer=playlist-what_s_the_future_of_food#t-218964) that they began during the *Interest Approach* portion of the lesson. Start at 2:29 (15:04 remaining).

Teacher Note:

At 3:40 (13:40 remaining), Sara makes the statement "...the world lacked an actionable guide for HOW we can avoid a global food crisis..." If you continue to the Summary Level of *Journey 2050*, students will engage in a Project-Based Learning activity create their own action plan to improve our world's sustainability.

3. After listening to the TED talk, explore which countries in the world have potential to increase crop yields on existing farmland (remember the goal is not to turn more land into farmland but to maximize the land already in production). Make sure at least one group explores India and African countries. Instruct students to consider the growing crop conditions (i.e. arable land, soil health, pests/diseases, water/climate), transportation/storage to get products to markets/market access, technology available, level of education within the country, access to capital to invest in new innovations/best practices, and anything else that would contribute to the success or failure of growing food sustainably. Then respond to the question, "Does the country I have selected have the ability to increase crop yields on existing farmland with all the resources required?"
4. Have the students share their findings, and ask them to evaluate the potential for stakeholders (producers, consumers, governments, environmentalists, non-profits, educators etc.) to contribute to successful advancements in the countries identified.
5. Summarize by discussing answers to the following questions:
 - What can developed and developing countries do to prevent a famine as we move toward 2050?
 - What can developed and developing countries learn from each other? Can technology and innovations be integrated from one country to another?

Activity 3: Impact of Consumer Choices

Teacher Note:

Food choices are not covered in Journey 2050 directly. As you carry out this activity, it's important that students understand that it's not always black or white when deciding what food choices support sustainability the most. For example, in recent years cattle have been criticized for producing methane which contributes to greenhouse gases and there has been a concern that developed countries over-consume red meat. However, it is important to consider the comparative and competitive economy, essentially recognizing that not all land is suitable for growing crops and that cattle can provide a protein source for people. Cattle are ruminants, so they graze on grasslands not suitable for growing crops. As they graze, their manure helps sequester carbon in the soil. In developing countries where few food choices exist, owning cattle reduces malnutrition. It's important that students understand the entire picture and make science-based decisions when making food choices. A similar discussion can be held around the practice of fish farming in land-based pools versus the ocean. The goal in feeding nearly 10 billion people is to ensure everyone has access to affordable, safe, and nutritious meals.

1. *Technology and Innovation* PowerPoint Slide 9: Direct the attention of the students to themselves. Ask, "How do consumers like yourself influence what producers grow?" As an example, ask students to raise their hand if they would eat insects as a source of protein. If they will eat insects, then demand for insects increases. If they won't, then demand decreases. Explain that every time we shop at a grocery store, we are sending a message to the agricultural value chain about what preferences we have.
2. How else do consumers influence growers? Ask students if they have seen campaigns ("Meatless Mondays" or "Milk: It Does a Body Good") or food labels (organic, Non-GMO, natural, cage-free, antibiotic free, etc.) that could influence someone positively or negatively about food. The following discussion should prompt the students to take a science-based, informed approach when viewing information they may see on social media or in marketing campaigns that is trying to influence their purchasing behavior.
3. Slide 10: Separate the classroom into small groups. Give each group one or two [snapAG information sheets](https://aitc-canada.ca/en-ca/learn-about-agriculture) (https://aitc-canada.ca/en-ca/learn-about-agriculture) (i.e. What are GMOs and are they okay to eat? What does organic farming look

like? How are chickens raised?). SnapAG is a series of resources that help students explore hot topics affecting the agriculture industry. Each group should answer the following questions:

- Are their own perceptions different or the same as the industry perceptions?
- Why do they have the perceptions that they do?
- Are their views based on science?
- How do consumer perceptions influence producers growing crops and raising animals.



Wrap-Up: (Slide 11)

After conducting these activities, review and summarize the following key concepts:

- Technology and innovation play a critical role in the future of agriculture. Each innovation must be understood for the benefits and limitations it brings as there is no one-size fits all solution.
- If supported, developing countries have the greatest potential to make the most improvements.
- Consumers have a direct influence on what is grown and how. It's important that students take a science-based, informed approach when viewing information they may see on social media or in marketing campaigns trying to influence their purchasing behavior.
- As we strive to feed a growing population, every stakeholder must act in a way that encourages sustainable solutions. We need to begin to solve the problems today. Waking-up to address these issues on January 1, 2050 is too late!



We welcome your [feedback](https://usu.co1.qualtrics.com/jfe/form/SV_4HhIVpN4L8IC2IT) (https://usu.co1.qualtrics.com/jfe/form/SV_4HhIVpN4L8IC2IT)! Please take a minute to tell us how to make this lesson better or to give us a few gold stars!

Enriching Activities

- Using the activity sheet found in the *Essential Files*, help students relate the technologies and innovations in their own life with those on the farm by completing the bingo-style *Technology & Innovation: Find Someone Who* activity.
- Watch the video [Will tech take over the farm?](https://www.youtube.com/watch?v=JPvjucZPZLM) (https://www.youtube.com/watch?v=JPvjucZPZLM) This video highlights the "Hands Free Hectare" farm in England where the entire farm uses autonomous robot technology.

- Listen to episodes from the [Future of Agriculture Podcast](https://futureofag.com/) (https://futureofag.com/).
- Hear from Iowa farmer, [Mark Jackson](https://www.ted.com/talks/mark_jackson_a_personal_story_about_farming_and_the_future_of_agriculture) (https://www.ted.com/talks/mark_jackson_a_personal_story_about_farming_and_the_future_of_agriculture), about the transformation of his family farm from the 1890s until today and moving into the future.

- To further explore specific technologies on the farm, see the following additional lesson plans:
 - [High-Tech Farming](https://agclassroom.org/matrix/lesson/691/). (https://agclassroom.org/matrix/lesson/691/)
 - [Drones in High-Tech Farming](https://agclassroom.org/matrix/lesson/692/). (https://agclassroom.org/matrix/lesson/692/)
 - [Robots in High-Tech Farming](https://agclassroom.org/matrix/lesson/693/). (https://agclassroom.org/matrix/lesson/693/)
 - [Growing a Nation: Growing Technology](https://agclassroom.org/matrix/lesson/709/). (https://agclassroom.org/matrix/lesson/709/)
- To further explore consumer choices and food labeling, use the lesson [Looking Under the Label](https://agclassroom.org/matrix/lesson/655/) (https://agclassroom.org/matrix/lesson/655/).
- Watch the video [Growing Today for Tomorrow](https://www.youtube.com/watch?v=ym6biFbr3GQ) (https://www.youtube.com/watch?v=ym6biFbr3GQ). Discuss how farmers have been able to continually produce more food with fewer resources.

- Watch the video [Turning waste into food and livestock feed through innovation](https://www.ceres-ab.com/about-us?wix-video-id=5f23646e1754458f8c6336be4df6ba68&wix-vod-comp-id=comp-j48u0gxt) (https://www.ceres-ab.com/about-us?wix-video-id=5f23646e1754458f8c6336be4df6ba68&wix-vod-comp-id=comp-j48u0gxt) to see an example of how a waste product can be up-cycled into a useable form.

Sources

1. https://croplife.org/wp-content/uploads/pdf_files/Getting-a-Biotech-Crop-to-Market-Phillips-McDougall-Study.pdf
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2. <https://johndeerejournal.com/2016/03/agricultures-past-present-and-future/>
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3. <https://croplife.org/news/agriculture-then-and-now/> (https://croplife.org/news/agriculture-then-and-now/)
4. <https://www.kqed.org/science/16676/drones-the-newest-water-saving-tool-for-parched-farms>
(https://www.kqed.org/science/16676/drones-the-newest-water-saving-tool-for-parched-farms)

Suggested Companion Resources

- [Journey 2050 Program Summary: Project-Based Learning](https://www.agclassroom.org/matrix/resource/765/) (https://www.agclassroom.org/matrix/resource/765/)
- [Agricultural Inventions: At the Top of the Field](https://www.agclassroom.org/matrix/resource/952/) (https://www.agclassroom.org/matrix/resource/952/)
- [Agriculture and the Sustainable Development Goals](https://www.agclassroom.org/matrix/resource/840/) (https://www.agclassroom.org/matrix/resource/840/)
- [Field Robots of the Future](https://www.agclassroom.org/matrix/resource/964/) (https://www.agclassroom.org/matrix/resource/964/)
- [Fighting Weeds: Can we reduce, or even eliminate herbicides by utilizing robotics and AI?](https://www.agclassroom.org/matrix/resource/972/) (https://www.agclassroom.org/matrix/resource/972/)
- [Food Facts: 7 Reasons to Eat Insects](https://www.agclassroom.org/matrix/resource/961/) (https://www.agclassroom.org/matrix/resource/961/)
- [How Reducing Food Waste Could Ease Climate Change](https://www.agclassroom.org/matrix/resource/775/) (https://www.agclassroom.org/matrix/resource/775/)
- [Precision Agriculture Technologies and Factors Affecting Their Adoption](https://www.agclassroom.org/matrix/resource/854/) (https://www.agclassroom.org/matrix/resource/854/)
- [Robotic Farming of the Future](https://www.agclassroom.org/matrix/resource/965/) (https://www.agclassroom.org/matrix/resource/965/)
- [Food Security & Nutrition Around the World](https://www.agclassroom.org/matrix/resource/721/) (https://www.agclassroom.org/matrix/resource/721/)

Author

Andrea Gardner, Lindsey Verhaeghe, and Debra Spielmaker

Organization Affiliation

National Center for Agricultural Literacy and Nutrien