Market to Market Classroom
Science and Technology in Agriculture
Teacher Notes

Contents
The Teacher Notes for this module includes the following items:
● Module Overview
● Learning Goals
● Standards and Cross-curricular Connections
● Discussion Questions
● Challenge Rubric
● Vocabulary
● Classroom Activities

Overview
The Science & Technology in Agriculture module demonstrates agriculture’s long history of technological innovations and their impact on the world. It expands on specific innovations to discuss their impact on the economy, environment, science, government, transportation, culture and society. The module challenges the reader to consider what the future of agriculture will be and what ethical considerations might be involved.

This module introduces students to several big ideas. Science and technology have played a role in agriculture since the first crops were planted. This continues today with genetic engineering, robotics, GPS, and other developments quickly changing the face of agriculture.

Learning Goals
This module connects with the following learning goals:
● Identify existing problems that can be solved through innovations in technology.
● Demonstrate the key components of the design process including identifying a problem, brainstorming possible solutions, designing, testing, and evaluating.
● Explain the impacts of outside entities, such as government or business, in the development of a new agricultural science or technology.
● Analyze ethical implications or considerations for a new agricultural science or technology.
● Hypothesize future applications for a new agricultural science or technology.
Standards and Cross-curricular Connections

The *Science and Technology in Agriculture* module offers several standards and cross-curricular connections:

Agriculture, Food and Natural Resources (AFNR) Standards

**National Council for Agricultural Education**

- Compare and contrast issues affecting the AFNR industry. (CS.09)
- Envision emerging technology and globalization to project its influence on widespread markets. (CS.10)
- Recognize the historical, social, cultural and potential applications of biotechnology. (BS.01)
- Use physical science principles and engineering applications with power, structural and technical systems to solve problems and improve performance. (PST.01)

Science and Engineering

**Next Generation Science Standards (NGSS)**

- Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. (HS-ETS1-2)
- Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. (HS-ETS1-3.)

Literacy in Science and Technical Subjects

**Common Core State Standards Initiative**

© Copyright 2010 National Governors Association Center for Best Practices and Council of Chief State School Officers. All rights reserved.

- Determine the central ideas or conclusions of a text; trace the text’s explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. (RST.9-10.2.)
- By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. (RST.9-10.10.)
- Write arguments focused on discipline-specific content. (WHST.9-10.1.)
- Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (WHST.9-10.2.)
- Gather relevant information from multiple authoritative print and digital resources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. (WHST.9-10.8.)

Social Studies

**National Council for the Social Studies**

**College, Career, and Civic Life (C3) Framework for Social Studies State Standards**

- Analyze the ways in which incentives influence what is produced and distributed in a market system. (D2.Eco.3.9-12.)
● Describe the possible consequences, both intended and unintended, of government policies to improve market outcomes. (D2.Eco.8.9-12.)
● Explain why advancements in technology and investments in capital goods and human capital increase economic growth and standards of living. (D2.Eco.13.9-12.)
● Explain how current globalization trends and policies affect economic growth, labor markets, rights of citizens, the environment, and resource and income distribution in different nations. (D2.Eco.15.9-12.)
● Evaluate the impact of human settlement activities on the environmental and cultural characteristics of specific places and regions. (D2.Geo.6.9-12.)

21st Century Skills
Partnership for 21st Century Skills
Framework for 21st Century Learning
● Using 21st century skills to understand and address global issues
● Using entrepreneurial skills to enhance workplace productivity and career options
● Understanding the local and global implications of civic decisions
● Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water and ecosystems
● Demonstrate knowledge and understanding of society’s impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
● Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
● Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)
Discussion Questions

Discussion questions provide you with opportunities to engage your students in the module topic.

1. What do you think is the most important scientific, technical, or engineering innovation to impact the agriculture industry in the last 100 years? What evidence can you find to support your choice?

2. Consider how science and technology in agriculture has evolved in the last 100 years. How do you envision it will change in your lifetime?

3. What agriculture-related problems exist now that technology can help solve?

4. Think about a new technology that you use, that you have seen in the news, or that was part of a science fiction movie. How might it be used in agriculture?

5. How can you take an active role in advocating for science, technology and engineering in agriculture?

6. How has technology changed the way farmers run their business and how commodities are traded?

7. Consider where you will be and what you will be doing in twenty years. How will you be using science, technology, or engineering in your work?

8. What types of ethical implications or unexpected consequences can arise with a scientific or technical innovation?

Challenge

The *Science and Technology of Agriculture* module Challenge invites students to imagine a new scientific, technical, or engineering innovation that will solve a problem. The problem can be one that exists now, or one that could happen in the future. The project-based framework requires students to think critically, creatively and to communicate their learning. The rubric can be used for student formative self or peer-evaluation, or for summative assessment by the teacher.

[View the Challenge](#)
[Download and View the Rubric](#)
Vocabulary

Below is a list of vocabulary terms used throughout the *Science & Technology in Agriculture* module. Students may use trusted sources to define each of the terms, including *The Science Dictionary*:

https://www.thesciencedictionary.com/

- Biodiesel
- Biotechnology
- Cross-pollinated
- Drought-tolerant plant (xerophyte)
- Furrow
- Genetically Modified Crops (GMO)
- Global Positioning System (GPS)
- Hybrids
- Pesticides
- Petroleum
- Yields
Classroom Activities
There are several ways the Science & Technology in Agriculture module can be used in your class. Below are a few activities ideas to consider using with your students.

Create a list: Using the Science & Technology in Agriculture background information, direct students to create a list of innovations. Then have students identify the issue or need that each innovation filled or addressed.

Compare timelines: Direct student to compare world population milestones and development of major agricultural technologies to discover any interesting correlations.

Social media: Engage with Market to Market to discuss technology and science innovations in agriculture using social media. If students are able to use Twitter or other social media platforms, encourage them to follow agriculture news related accounts for a few days or weeks leading up to the conversation. Remind students about social media etiquette.

Guest expert: Engage with a professional involved in an agriculture-related STEM occupation so students can interact with the professional and ask questions. Suggested questions may include:
- What they enjoy about the job and industry
- What types of project(s) they have been involved in
- What innovation they feel has impacted agriculture the most during their lifetime
- What they predict for the future of the industry
- What advice they have for students interested in a career in the industry
If the guest cannot visit your classroom and you cannot take a field trip, consider a web-based conversation such as Skype or FaceTime.

Ethics discussion: Discuss how ethics relate to innovations in agriculture. Consider having students create a survey to collect responses from peers in school or a broader community about a current debate regarding an agricultural innovation (ex: GMOs, cloning, pharming, biofuel, etc). Discuss the following questions:
- What are some ethical considerations in each innovation listed?
- How do misconceptions shape ethical debates and decisions?
- How should decisions be made regarding ethical considerations?
- Who should make the decisions?

Predict the future: Have individual students identify 2-3 innovations of interest that are used in worldwide agriculture today. An innovation may be as simple as a simple, mechanized well pump assembly in Africa or small biodigesters in Latin America. The innovations may also be complex and highly technical such as infrared scanning for fertilizer applicators or GMOs. Direct students to discuss in groups and then predict at least two ways that each could be improved or added to in order to improve agriculture either in the same region or in another region.
150-word essays:
Consider using these essay topics as assessments or as general writing prompts:

1. Choose an innovation or technology. Give the background, describe how it works and discuss the ethical issues surrounding it (including today, past, and future concerns).
2. Choose an invention, innovation, or technology. How will it be applied to agriculture in the future? How and why?
3. Research an agricultural innovation or technology not listed in the article. How did it change the face of farming? Are there ethical concerns involved?
4. Highlight an invention you think is one of the most important developments in modern agriculture and defend your position.