**The relationship between agriculture and food, fiber, and energy**

**Pillar 2 F. Differentiate between natural, certified organic, and conventional farming practice**

 (9th – 12th Grade)

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| **Websites**: <https://healthyplanetus.org/healthy-growing/resources/garden-based-lessons/garden-based-lessons-and-curriculum/project-based-lessons/organic-vs-conventional-farming/> <https://healthyplanetus.org/wp-content/uploads/2014/04/LessonPlanOrganicvsConventionalFarming.pdf> <https://www.youtube.com/watch?v=WhOrIUlrnPo> **Hands On**: <http://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=397&grade=9&author_state=0>  |

**FARMLAND: GMOs and Organic Agriculture**

**Purpose**

Students will use the film *FARMLAND* to gain a basic understanding of genetically engineered crops and compare conventional and organic farming practices.

**Materials**

* *FARMLAND* documentary, short version, clip from 12:45-23:40
	+ This documentary is available for online streaming from Amazon Prime, iTunes, Netflix, YouTube, and more. The film is available in the full documentary format (77 minutes) or the short, education version lasting 44 minutes. The time stamp indicated for the lesson corresponds to the 44-minute educational version.
* DVD and YouTube video viewing capabilities
* *GMOs and Organic Agriculture Pretest*
* *KWL Chart*
* Sticky notes, 1 per student

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

* [KWL Chart](http://naitc-api.usu.edu/media/uploads/2016/01/04/KWL_Chart.pdf%22%20%5Ct%20%22_blank)
* [GMOs and Organic Agriculture Pretest KEY](http://naitc-api.usu.edu/media/uploads/2016/01/04/GMOs_and_organic_ag_pretest_key.pdf%22%20%5Ct%20%22_blank)
* [GMOs and Organic Agriculture Pretest](http://naitc-api.usu.edu/media/uploads/2016/01/04/GMOs_and_organic_ag_pretest.pdf%22%20%5Ct%20%22_blank)

**Vocabulary**

**GMO:** genetically modified organism; an organism whose genome has been altered by the techniques of genetic engineering so that its DNA contains one or more genes not normally found there

**Biotechnology:** the use of living cells, bacteria, etc. to make useful products or the process of intentionally making a copy of a gene for a desired trait from one plant or organism and using it in another plant

**Genetic engineering:** the deliberate modification of the characteristics of an organism by manipulating its genetic material

**Organic farming:** USDA regulated farming without the use of synthetic pesticides, artificial growth hormones, or antibiotics

**Transgenic:** an organism that contains genetic material into which DNA of an unrelated organism has been artificially introduced

**Did you know? (Ag Facts)**

* 88% of scientists believe that GMOs are safe to eat.3
* 89% of U.S. corn produced is GMO.4
* 94% of U.S. soybeans produced are GMO.4
* There are 18,513 certified organic farms and business in the United States.5

**Background Agricultural Connections**

**Biotechnology** plays a huge role in agriculture. Many farmers across the U.S. choose to plant **GMO** crops every year, while others choose to plant non-GMO crops and grow them according to set standards so that they can be labeled as "organic."

**Interest Approach – Engagement**

1. Administer the *GMOs and Organic Agriculture Pretest* to the students without discussing the topics of GMOs or organic vs. conventional food production.
2. Allow students to answer the quiz questions based on their own prior knowledge.
3. Review questions as an entire class, and create a *KWL Chart*. Have students write what they know about GMOs and organic agriculture in one column, what they want to know in the next, and then at the end of the lessons have them complete the last column with what they have learned.

**Procedures**

1. Give a brief introduction of GMOs and the science behind them.
	* Play either the *[How Are GMOs Created?](https://www.youtube.com/watch?v=2G-yUuiqIZ0" \t "_blank)* Or the *[What is the difference between cross breeding, GMO and cross pollination?](https://www.youtube.com/watch?v=uVWsDUWRgT4" \t "_blank)* videos for the class. Ask them to take notes on the science behind the technology. Using the [Crop Breeding and Genetic Improvement Comparison Chart](http://1.bp.blogspot.com/-FFFjXDpHPAo/U-DENhhkAaI/AAAAAAAAFgo/bRPXrXJd1Bk/s1600/GMtable3.jpg%22%20%5Ct%20%22_blank) may be helpful to display for students to compare GMOs to other breeding methods after watching the video.
	* Some talking points may include:
		+ Vocabulary surrounding biotechnology can be very confusing. Work through the definitions of GMO, genetic engineering, transgenic and biotechnology found in the *Vocabulary* section.
		+ Genetic engineering allows scientists to transfer genes from one species to another for crop improvements such as longer shelf life, insect or disease resistance, or added nutrition.
		+ GMOs are heavily tested before reaching the market – in fact, they are tested far more than conventionally bred foods. It takes 13 years for a GMO to make it to the market. GMOs are tested for nutrient composition, non-nutrient composition and potential presence of allergens.
		+ GMOs are grown, used or imported to 70 different countries.
		+ The U.S. is the world’s largest grower of GMOs.
2. Ask students if they believe they have ever eaten a GMO and facilitate a class discussion on the prevalence of GMO foods.
	* Some students may believe they have not, but most processed foods contain corn or soybeans, which may have been processed from a GM seed. Some examples of processed foods containing corn or soy would be soda, most candy, cookies, soups, and granola bars. Ask students to support their answers with prior knowledge (i.e., ‘my family only eats organic food,’ ‘I know that most produce is not genetically modified,’ etc.). The most focus should be on the reasoning and prior knowledge of the students, and what conclusions they can draw from the information given. At the end of the discussion, reveal to students that there are only nine commercially available genetically engineered crops, with apples soon to join the list. Chances are that all the students in the class have eaten GMOs, even if they didn’t know it.
3. Play the clip from the movie *FARMLAND*. Ask students to take careful notes on the various farmers’ thoughts on chemicals, GMOs, and organic production.
4. Have students create a “tug of war” with the information from the film. Have them identify factors that “pull” either side of the dilemma, and then “tugs” or reasons to support either side of the dilemma. This can be done by writing the pulls on either side of a white board, and having students use sticky notes to write down their tugs and stick them to the tugs. Then, some discussion questions could include:
	* Why do you think the public perception of GMOs is such a challenge for the agriculture industry?
	* Which farmer do you agree with the most?
	* What are the farmers’ reasons for growing GMO crops?
	* Do the farmers reassure you of the safety of genetically engineered crops?
	* What are some of the benefits of biotechnology the farmers discuss?
	* If you were a farmer, do you think you would grow GMO crops?
5. Introduce the idea of organic farming to students. Begin by asking if students are familiar with the term and what they think it implies about the food products.
6. Introduce the following farm scenarios to students, and have them answer the associated questions using their newly gained background knowledge.
	* Leighton is considering expanding his business to earn more money. He knows that organic farmers receive a higher price for their crops, but also knows that he must farm organically for 3 years before he can become certified organic and receive the premium. Still, he is interested and comparing the pros and cons of organic and conventional farming. What are the pros and cons of organic farming? What are the pros and cons of conventional farming?
	* Margaret is looking for new ways to market her products. She is told by a marketing company that if she labels her produce “non-GMO” consumers may be more inclined to buy it. Based on Margaret’s comments in the movie clip and your knowledge of GMOs, what do you think she would do in this situation?
	* Sutton, the organic farmer in the movie, receives a relatively large premium for his organic onions compared to conventional onion farmers. However, a new onion virus is coming through California, where he farms. There is a new GMO onion that is resistant to the virus that will be coming onto the market soon. It works similarly to the GMO papaya.
		+ Is Sutton allowed to raise the new GMO onion and sell it as organic?
		+ What are some pros and cons of this situation?
		+ If you were Sutton, how would you handle this situation?
7. Have students return their focus to the practice test or *KWL Chart* they worked on at the beginning of the lesson, and give them 5 minutes to work in pairs and correct their quizzes. Then, read them the correct answers. How many questions did they get right? What were some of the most commonly missed questions? Were students surprised by any of the answers to the questions? Is there anything they still have questions about?

**Concept Elaboration and Evaluation**

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

* Biotechnology can be used to develop plants with unique genetics that make them resistant to specific diseases, pests, or herbicides.
* Foods labeled with the green and white "USDA Organic" label were produced under specific guidelines regulating the use of chemicals to control pests or weeds and the types of fertilizer that can be used. GMO seeds cannot be used in organic food production.
* In "conventional" food production farmers are allowed to use herbicides, pesticides, and synthetic fertilizers. They may also utilize the benefits of GM seed varieties.
* Farmers choose what type of production system (conventional or organic) their farm will be. Consumers can also choose to purchase food that was produced organically or conventionally.

**Enriching Activities**

* Have students create scientific brochures about GMOs. Rate them on the factuality of the information and creativity.
* Have students write a position paper on conventional vs. organic farming. Have students choose either organic or conventional agriculture, research the topic, and write about the most significant benefits and concerns of either practice.
* Allow students to explore the controversy surrounding the debate on GMOs. Have one side of the class represent a pro-GMO group and the other represent a group that is more cautious of the technology. Have students research their arguments, cite their sources and discern between biased and unbiased information. Students should be able to acknowledge the conflicting information about GMOs and the benefits and risks of the technology by the end of the debate.
* Have students with strong science backgrounds identify current problems in agriculture (nutrient deficiencies, fertilizer runoff, food waste, etc.), a possible transgenic solution to that problem, and the global impact of the solution. For example: Humans waste a huge amount of potatoes because they have black bruises on them. The solution to this problem is a GMO potato that doesn’t brown, and that means much less waste all over the globe. o Corn requires high amounts of nitrogen, and it cannot fix its own nitrogen like soybeans, with their root nodules and nitrogen-fixing bacteria, can. Farmers have to apply large amounts of nitrogen to the fields to produce quality corn, but the nitrogen can runoff and is damaging to the environment. The solution is to create a GMO corn plant that can produce nodules and sustain the nitrogen-fixing bacteria to stop nitrogen runoff, prevent further damage to the environment and save farmers thousands of dollars on fertilizers.

**Suggested Companion Resources**

* [Genetically Engineered Crops in the United States Report](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=752) (Multimedia)
* [The Question of the Production of Genetically Modified Foods](http://www.agclassroom.org/teacher/matrix/resources.cfm?rid=753) (Website)

**Sources/Credits**

1. [http://johnmuir.ucdavis.edu/the-debate-about-gmo-safety-is-over-thanks-to-a-new-trillion-meal-study](http://johnmuir.ucdavis.edu/the-debate-about-gmo-safety-is-over-thanks-to-a-new-trillion-meal-study%22%20%5Ct%20%22_blank)
2. [https://www.cga.ct.gov/2013/KIDdata/Tmy/2013HB-06527-R000305-Scientific%20Bodies%20Afffirming%20Safety-TMY.PDF](https://www.cga.ct.gov/2013/KIDdata/Tmy/2013HB-06527-R000305-Scientific%20Bodies%20Afffirming%20Safety-TMY.PDF%22%20%5Ct%20%22_blank)
3. [http://www.huffingtonpost.com/jon-entine/post\_8915\_b\_6572130.htm](http://www.huffingtonpost.com/jon-entine/post_8915_b_6572130.html%22%20%5Ct%20%22_blank)l
4. [http://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx](http://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx%22%20%5Ct%20%22_blank)
5. [http://www.usda.gov/wps/portal/usda/usdamediafb?contentid=2014/03/0043.xml&printable=true&contentidonly=true](http://www.usda.gov/wps/portal/usda/usdamediafb?contentid=2014/03/0043.xml&printable=true&contentidonly=true" \t "_blank)