| **Global Food Security and GMO Usage**Author: Austin Jenkins |
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| **Unit Overview**  |
| **Target Audience:** Middle / High School (Grades 8 - 10) | **Est. Time:** Three 45 - 55 minute class periods | **Content Area(s):** Science, Biology |
| **Abstract:**In this mini-unit, students will be exposed to the overarching problem of global food security, factors that influence global food security, and potential solutions (GMOs). The unit begins with a simulation where students will be introduced to some of the factors that contribute to food insecurity as well as situations that can preserve food security. Afterwards, students will use their learning from the simulation to begin constructing an initial model for how to solve a problem related to global food security. In the second lesson, students will be introduced to genetically modified organisms (GMOs) and conduct research using relevant and credible sources to explore the benefits and concerns associated with GMO food usage. In the final lesson, students apply this learning about GMOs to revise their initial model of solving a food security challenge. This interdisciplinary unit engages students in Indiana science and English/Language Arts standards as well as Next Generation Science Standards on engineering design. Students will utilize science content and the engineering design process to develop a working model for solving a 21st-century challenge. |
| **Unit Goals/Objectives:**After this unit, students will…1. Identify and explain how social, political, economic, and environmental factors contribute to global food insecurity
2. Research a variety of topics and read grade-level nonfiction text for comprehension independently
3. Differentiate genetically modified organisms (GMOs) from other options like selective breeding
4. Cite benefits and consequences of using GMOs in food production
5. Apply research and knowledge to construct a model for solving global food security challenges
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| **Lesson Summaries:**Lesson 1: Global Food Security as a Problem- Constructing the Initial Model Students will identify common challenges to food security, use a simulation to explain how agriculture, social, economic, and political challenges affect food security, and construct an initial model for solving a food security challenge.Lesson 2: Solutions to Global Food Security- Introduction to GMOsStudents will differentiate genetic modification from selective breeding/ other non-GMO technologies, research the usage of GMOs in relevant and credible sources, and cite a benefit and consequence of GMO usage.Lesson 3: Revisiting our Initial Model- Making Room for GMOsStudents will summarize current research on the usage of GMOs and apply knowledge of GMOs to revise the initial model for solving global food security. |
| **Lesson Timeline:**Lesson 1: Global Food Security as a Problem- Constructing the Initial Model  Lesson 2: Solutions to Global Food Security- Introduction to GMOs Lesson 3: Revisiting our Initial Model- Making Room for GMOs |
| **Standards:**Indiana State Standards * Science (<https://media.doe.in.gov/news/grade-8-science-standards-revised.pdf>)

Next Generation Science Standards**8.LS.10**- Gather and synthesize information about how humans alter organisms genetically through a variety of methods**8.RN.1**- Read a variety of nonfiction within a range of complexity appropriate for grades 6-8. By the end of grade 8, students interact with texts proficiently and independently.**8.SL.4.2-** Create engaging presentations that integrate multimedia components and visual displays to clarify information, strengthen claims and evidence, and add interest.**T4.6-8.i**- Provide examples of science and technology used in agricultural systems and explain how they meet our basic needs; detail their social, economic, and environmental impacts**MS.ETS1-1**: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (*Next Generation Science Standards*)**MS.ETS1-4**: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. (*Next Generation Science Standards*) |
| **STEM Integration within the Unit:**The unit was based on integrating science, engineering, English/ Language Arts, and agriculture. The science component of the mini unit is based on an 8th grade science standard of differentiating genetic modification from other types of modification, like selective breeding, that humans use to alter organisms. Further, I used the Next Generation Science Standards to integrate engineering design standards surrounding identifying criteria and constraints for a challenge and then creating a revisable model given those criteria and constraints. I connected agriculture standards to my unit through the National Agricultural Literacy Outcomes document concerning how science and technology can be used to impact agricultural systems. Overall, my unit integrated content and skills from science, engineering, and English/ Language Arts to solve a problem rooted in the agriculture and food sector. To plan this unit, I started with the 21st century challenge of how to solve global food security. Given my view that an integrated unit should be rooted in student’s trying to solve a real-world problem by enacting skills and knowledge from a variety of contents, this seemed like a logical starting point. After deciding on the challenge students would work to address, I thought about what I would accept as demonstrated mastery of working to solve the challenge. Project-based learning made sense here as I wanted the final product to be a working model of solving a global food security challenge when they are given criteria and constraints. Once the challenge and final product were solidified, I began outlining what knowledge, skills, and mindsets students would need from science, engineering, and Language Arts to accomplish creating a model. For example, research has shown that certain genetically modified organisms (GMOs) could be used to alleviate global food security challenges. Thus, I decided to incorporate that as the science knowledge that students would need to have to develop their final model. However, science content knowledge would not be enough to construct this final model. This is where I decided to integrate some engineering concepts, such as criteria and constraints, that students would need to understand to develop their initial and revised model for solving a food security challenge.  |
| **Background Information:**Access to high quality, nutritious food is a persistent problem plaguing the 21st century in developed and developing countries alike. There are a plethora of challenges associated with ensuring a population has access to high quality food including climate change, war and conflict, access to water and irrigation technology, and poverty. While there has been progress in addressing some of these challenges, millions of people go hungry across the globe daily. One proposed solution for addressing global food security that has been growing momentum is the use of genetically modified organisms (GMOs). GMOs could alleviate the need for the use of harsh pesticides or the need for constant irrigation thereby reducing the health risks associated with food or ensuring farmers are not limited by access to resources. However, there still remains a great deal of uncertainty and skepticism surrounding the use of GMOs as a viable solution to solve global food insecurity challenges. Evaluating the use of GMOs as a potential solution will require careful consideration about the benefits and consequences on not only our planet but society as a whole. While much is still unknown, multidisciplinary teams are working tirelessly to generate accurate and up-to-date information about how GMOs could be the solution to global food insecurity that people are desperately waiting for.  |

| **Lesson 1: *Global Food Security as a Problem - Constructing the Initial Model*** |
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| **Est. Time:** 45 - 55 minutes |
| **Lesson Learning Goals/Objectives:**1. Identify common challenges to food security
2. Use a simulation to explain how agriculture, social, economic, and political challenges affect food security
3. Construct an initial model for solving a food security challenge
 | **Standards:**Indiana State Standards:8.LS.10- Gather and synthesize information about how humans alter organisms genetically through a variety of methodsMS.ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.  |
| **Assessments****Pre-Assessment:**Agree or disagree worksheet will be used to understand what students currently know and understand surrounding global food security and GMO usage. They will be presented with six statements that they must mark if they “Agree” or “Disagree” with the statement and provide a reason why. Each lesson is designed to support students in making sense of the six statements on the pre-assessment**Formative:**Self-reflection: At the conclusion of Lesson 1, students will reflect on the following prompt: On a scale of 1-5 (with 1 being not at all and 5 being completely), how well do you think you met our learning outcomes for today. Cite evidence from class to support your answer. This formative assessment is meant to build student’s metacognitive abilities and ability to reflect on their own learning. It also gets students in the habit of supporting their claims with evidence as a scientifically literate citizen should. These responses could be used as a point of check-in for students in subsequent lessons if they feel like they are not meeting lesson goals |
| **Concept Prerequisites or Background Knowledge Needed:**Food security/insecurity |
| **Vocabulary:**Food security/insecurity, genetically modified organism (GMO) |
| **Materials & Technology Needed:**Pencils Food security images Whiteboard/ poster paper MarkerBingo chips Food insecurity statements Food Security Modeling handout PowerPoint with learning outcomes Index card Lesson 1 Worksheets:Food Security\_PreTestGlobal Food Security Simulation InitialModeling |
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| **Lesson Component** | **Instructions** | **Materials** |
| **Introduction***8 minutes* | Overview the lesson and discuss learning objectives (3 minutes)[**Pre-assessment**](https://docs.google.com/document/d/1AoWCS2tmGgfCB5aQW2A8L0vVvRvNrhkE/edit?usp=sharing&ouid=117715383746210907040&rtpof=true&sd=true)(5 minutes) * Have students complete the pre-assessment for the mini-unit (linked above) silently and independently
 | Copies of pre-assessmentPencils  |
| **Instructional Activities***30 minutes* | **Food Security Introduction (5 minutes):**Students will be exposed to a series of images that relate to food security. As a whole class, brainstorm some common challenges that could affect food security. Teacher will keep a running list of ideas on the board.  | Food security images Whiteboard/ poster paper Marker  |
| **Simulation (10 minutes)**Students will work as a whole class to complete the food insecurity simulation (attached at the end)Students will then share out any additional food insecurity statements they think should be added to the pile upon completion of the simulation. | Bingo chips Food insecurity statements  |
| **Initial Modeling (15 minutes)**Students will work in small groups (3-4 students) to complete the initial modeling of food insecurity handout (attached at the end) Teachers should circulate to hear student’s thoughts about how they would solve the initial food security challenge.  | Food Security Modeling handout Pencils  |
| **Wrap Up,****Synthesis/Closure***5 minutes* | **Exit Ticket:**Formative assessment: Self-reflection * On an index card, students will answer the following questions:
* On a scale of 1-5 (with 1 being not at all and 5 being completely), how well do you think you met our learning outcomes for today? Cite evidence from class for your answer
 | PowerPoint with learning outcomes Index card Pencil  |
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| **Resources:** Evaluating GMO Perspectives Lesson Plan (<https://agclassroom.org/matrix/lesson/86/>) |

| **Lesson 2: *Solutions to Global Food Security - Introduction to GMOs*** |
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| **Est. Time:** 45 - 55 minutes |
| **Lesson Learning Goals/Objectives:**1. Differentiate genetic modification from selective breeding/ other non-GMO solutions
2. Research the usage of GMOs using relevant and credible sources
3. Cite a benefit and consequence of GMO usage
 | **Indiana State Standards:**8.LS.10- Gather and synthesize information about how humans alter organisms genetically through a variety of methods8.RN.1- Read a variety of nonfiction within a range of complexity appropriate for grades 6-8. By the end of grade 8, students interact with texts proficiently and independently. |
| **Assessments****Formative:**The GMO Research Activity can serve as a formative assessment for how students are navigating finding credible sources, making meaning of grade-level text, and summarizing nonfiction text. Circulating while students are working on this formative assessment could help teachers plan mini-lessons on topics or pull a small-group of students for additional supportStudents will complete an exit ticket at the conclusion of Lesson 2 on the following prompt: On an index card, cite one benefit and one consequence of using GMOs to solve our global food security problem. This exit ticket will help instructors understand what key information students are taking away from their research and can serve as a conversation starter for completing the Summarize GMO Research Activity in Lesson 3 |
| **Concept Prerequisites or Background Knowledge Needed:**Lesson 1 content: food security and influences on food security |
| **Vocabulary:**Food security/insecurity, genetically modified organism (GMO) |
| **Materials & Technology Needed:**ProjectorVideo: <https://www.youtube.com/watch?v=Czx8nF7GrIM> NotebookPaperPencilsComputer/ device with internet capability for each studentGMO Research handoutIndex CardsGMO Research Worksheet |
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| **Lesson Component** | **Instructions** | **Materials** |
| **Introduction***10 minutes* | Overview the lesson and discuss the learning objectives (3 minutes)**Introduction to GMOs** [**Video**](https://www.youtube.com/watch?v=Czx8nF7GrIM) (7 minutes)Ask students if they have ever heard of the term GMO. Where have they heard the term before? What have they heard? Tell students that scientists/ engineers think one way to solve the global food security problem is using GMOs. Show students the Introduction to GMOs video (linked under activity). While students are watching, ask them to record: 1. One piece of information that surprised you.
2. One question or wondering you still have.

Teacher will collect this paper and review as a formative assessment to guide the third lesson  | GMO videoNotebook paperPencils |
| **Instructional Activities***30 minutes* | **GMO Research**Students will work individually or in partners to complete the GMO Research (linked under Activity). Teachers should circulate and check in with students to ensure they are using credible sources and citing their information. | Computer/ device with internet capability GMO Research handoutPencils  |
| **Wrap Up,****Synthesis/Closure***5 minutes* | **Exit Ticket:**Formative Assessment: On an index card, cite one benefit and one consequence of using GMOs to solve our global food security problem | Index card Pencils  |
|  |
| **Resources:** Evaluating GMO Perspectives Lesson Plan (<https://agclassroom.org/matrix/lesson/86/>)GMOs – Top 3 Pros and Cons: <https://www.procon.org/headlines/gmos-top-3-pros-and-cons/>  |

| **Lesson 3: *Revisiting our Initial Model - Making Room for GMOs*** |
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| **Est. Time:** 45 - 55 minutes |
| **Lesson Learning Goals/Objectives:**1. Summarize current research on the usage of GMOs
2. Apply knowledge of GMOs to revise the initial model for solving global food security
 | **Indiana State Standards:**8.LS.10- Gather and synthesize information about how humans alter organisms genetically through a variety of methods8.SL.4.2- Create engaging presentations that integrate multimedia components and visual displays to clarify information, strengthen claims and evidence, and add interest.T4.6-8.i- Provide examples of science and technology used in agricultural systems and explain how they meet our basic needs; detail their social, economic, and environmental impactsMS.ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutionsMS.ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.  |
| **Assessments****Formative:**Students will come together with the instructor to summarize their research findings from Lesson 2. This will give the instructor to fill in any gaps that the research did not provide and answer any lingering questions students may have about the usage of GMOs**Summative:**Initial Model RevisionStudents will work in small groups (3-4 students) to develop a poster/ PowerPoint presentation outlining their proposed solution to solving global food insecurity problems. Students can build on their initial model they created in Lesson 1 or choose to develop a new model given the same challenge to food security. They will address the following: * Identify a problem to global food security
* Propose a potential solution to the problem
* Outline steps to implement this solution
* Identify stakeholders that will need to be involved in implementation
* Identify complications/ problems with the proposed solution
* Make a claim about GMO usage in the proposed solution

Students will be evaluated on a rubric linked in Lesson Plan 3.Post-Assessment |
| **Concept Prerequisites or Background Knowledge Needed:**Lesson 1 & 2 content |
| **Vocabulary:**Herbicide, food security/insecurity, genetically modified organism (GMO) |
| **Materials & Technology Needed:**GMO Research Graphic Organizer PencilsPencils Markers/ Colored PencilsPoster Board OR computer and internet accessGMO Research Graphic OrganizerFood Security Model RubricLesson 3 worksheets:* GMOSummaryOrganizer
* FoodSecurity\_PreTest (use as post-assessment)
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| **Lesson Component** | **Instructions** | **Materials** |
| **Introduction***3 minutes* | Overview the lesson and discuss learning objectives |  |
| **Instructional Activities***37 minutes* | [**Summarize GMO Research**](https://docs.google.com/document/d/1uptm5gH9FUy1HOHPa6R5vqODspPAcUJe/edit?usp=sharing&ouid=117715383746210907040&rtpof=true&sd=true)(7 minutes)Teachers will walk students through a graphic organizer (linked under activity) to summarize information learned about GMOs and their usage. | GMO Research Graphic Organizer Pencils  |
| **Initial Model Revision** (30 minutes)Students will revisit their initial model from Lesson 1 and incorporate their new knowledge about GMOs into their solution for solving global food security challenges. Students will construct a poster/ Google Slides presentation outlining their model for solving global food security challenges. Students will be given a [rubric](https://docs.google.com/document/d/1I_iWfps950OgVp08_NyyulaSml2UiYcd/edit?usp=sharing&ouid=117715383746210907040&rtpof=true&sd=true) to assess their own model if they finish early. | [Rubric](https://docs.google.com/document/d/1I_iWfps950OgVp08_NyyulaSml2UiYcd/edit?usp=sharing&ouid=117715383746210907040&rtpof=true&sd=true) Pencils Markers/ Colored PencilsPoster Board OR computer and internet access |
| **Wrap Up,****Synthesis/Closure***5 minutes* | Summative assessment: [Post-assessment:](https://docs.google.com/document/d/1AoWCS2tmGgfCB5aQW2A8L0vVvRvNrhkE/edit?usp=sharing&ouid=117715383746210907040&rtpof=true&sd=true) Students will take the post-assessment (linked under activity) silently and independently | Post-assessmentPencils  |
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| **Resources:** Evaluating GMO Perspectives Lesson Plan (<https://agclassroom.org/matrix/lesson/86/>) |

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**Global Food Security Mini-Unit**

**Pre- and Post-Assessment**

**Directions:** Mark if you “Agree” or “Disagree” with each of the following statements and then provide a 1-2 sentence reason for why you picked that answer.

| **Agree** | **Disagree** | **Statement** | **Reason** |
| --- | --- | --- | --- |
|  |  | All foods are genetically modified. |  |
|  |  | Inserting a gene for herbicide resistance IS an example of genetic modification. |  |
|  |  | Genetically modified organisms (GMOs) can help farmers provide enough food to feed the population. |  |
|  |  | There are only benefits that come with using genetically modified organisms (GMOs) |  |
|  |  | A consequence of using genetically modified foods (GMOs) is the environmental concern of resistance in other organisms. |  |
|  |  | Global food security is NOT a problem—everyone has access to enough food. |  |

 **Global Food Security Mini-Unit**

**Food Security Simulation**

**Suggested Grade:** 6-8th grade

**Suggested Time:** 30 minutes for prep and 10-15 minutes for implementation

**Materials:**

1. Bingo chips
2. Food Security Statements

**Procedure:**

1. Prepare the Food Security Statements on index cards or print them out.
2. Arrange students in small groups (3-4 individuals)
3. Give every student 10 bingo chips
4. Give each group a set of Food Security Statements
5. Each group member will take turns drawing a statement. The student will gain or lose food items depending on the situation.
6. A student is OUT when they run out of food items. The round will continue until every student has ran out of food items.

**Discussion Questions:**

1. Did you notice if there were more positive or negative cards? What do you think this tells you about the challenges to global food security?

**a. Sample answer:** *There are more negative cards. This tells us there are a lot of challenges to preserve food security. Also, the positive cards only seemed to impact certain people while the negative cards could impact everyone.*

2. What did you notice about the cards? Who contributes to global food security

**a. Sample answer:** *Everyone plays a role in contributing to global food security. People like farmers and engineers help address the challenges of food security while consumers feel the effects of that work and can also contribute to food insecurity.*

3. Could you think of any more positive or negative situations to add? What are they?

**a. Sample answer:** *Answers will vary*

**Food Security Statements**

| A harsh winter limited the amount of food harvested and thus available. **Lose 2 food items** |
| --- |
| Climate change has caused a drought so crops are dying. **Lose 2 food items** |
| Due to COVID-19 the grocery store close to you closed. **Lose 1 food item** |
| You got a raise at work and can afford extra food.**Add 2 food items** |
| Due to COVID-19, there are less truckers transporting food to the stores.**Lose 2 food items** |
| An engineer developed a new herbicide to protect crops from pests.**Add 2 food items** |
| A new invasive beetle is attacking crops and limiting food supplies.**Lose 3 food items**  |
| You fear the term “GMO” on the food label at the grocery store. There is not another alternative**Lose 1 food item** |
| A geneticist has isolated a freezing tolerance gene so we can plant crops in new lands.**Add 2 food items** |
| A farmer lost his farm to the biofuel industry, which limits land for food production.**Lose 2 food items** |
| A farmer cannot afford the new pesticide to combat the invasive beetle.**Lose 1 food item** |
| A farmer is able to get a loan from the bank to install a new, more efficient irrigation system.**Add 2 food items** |
| There is a war that is limiting the trade of food goods.**Lose 4 food items** |
| You lost your job and can not afford to buy your favorite brands of food.**Lose 2 food items** |
| You have more information about GMOs and can make a more informed decision about buying food.**Add 2 food items**  |
| You have not seen fresh produce at your grocery store in days. You are not sure when it will be back.**Lose 1 food item** |
| The closest grocery store to you is 35 minutes away.**Lose 2 food items** |
| Developers are building a new grocery store around the block from your apartment.**Add 2 food items** |
| The number of farmers is declining as people are getting older, which limits food production.**Lose 3 food items** |
| A tornado destroys a farmer’s entire crop for the year.**Lose 3 food items** |
| Crop yield was higher than expected this year.**Add 2 food items** |
| An oil company discovered oil on your farm land so the government has asked to buy your land. This limits food production.**Lose 2 food items** |

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Class \_\_\_\_\_\_\_\_

**Global Food Security Mini-Unit**

**Creating an Initial Model Guide**

**Directions:** Work with your small group to complete the questions below to guide your thinking about your initial model for solving a food security problem.

**Part 1: The Challenge**

Below are some common examples of challenges to food security. You can use one of these challenges below or think of your own!

* Climate change and food production
* Loss of farmland (land changes and habitat fragmentation/loss)
* Pests and diseases
* Water stress (lack of access to water)
* Conflict and war
* Poverty

| **Our group would like to address the food security challenge of…****Because…** |
| --- |

**Part 2: Problem Scoping**

Use the internet to explore at least two (2) resources that describe the food security challenge you picked in Part A

| **Helpful Notes** | **Website Address/ Link** |
| --- | --- |
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**Part 3: Initial Solution**

After doing some basic research, our group proposes a solution to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
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Complete the table below to begin constructing your initial model.

| **Our proposed solution is…** |
| --- |
| **We can implement this solution by…** 1.

 1.
2.

 1.

  | **Some challenges associated with this solution might be…**1.
2.
3.
 |

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Class \_\_\_\_\_\_\_\_\_\_

**Global Food Security Mini-Unit**

**Introduction to GMOs Research**

**Directions:** Use credible and relevant sources to answer the questions below about genetically modified organisms (GMOs).

| **Remember…**1. Credible sources often end in .org, .gov, or .edu. However, always double check the date the website was written (if available) and that there are no spelling errors2. All information written here should be in YOUR OWN WORDS (summary of what you read) and then give the website link from where you got the information.3. If you are struggling to find information about the question, please ask for help! We can search together |
| --- |

| **Question** | **MY Answer** | **Website Address** |
| --- | --- | --- |
| How is genetic modification different from selective breeding? |  |  |
| How many approved GMO foods are there? What are they? |  |  |
| List 3 benefits of using GMO foods |  |  |
| List 3 concerns people have about using GMO foods |  |  |
| How could GMOs help solve food security problems? |  |  |

**Initial Opinions**

Pick a stance by circling one option below

 We **SHOULD** use GMOs to solve food security problems

 We **SHOULD NOT** use GMOs to solve food security problems

Cite 2 reasons from your research for why you think that. Be sure to cite the specific website where that information came from.

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**Global Food Security Mini-Unit**

**GMO Summary Graphic Organizer**









