FOOD FOR 9 BILLION

The Challenge of Feeding the World

Arable Land and Food Production

Teacher Notes

Before You Start

Grade Level:
Grade 9-10

Concepts Covered:
Arable land, cereal crop yield

Time Frame:
30-50 minutes

Materials Needed:
Student Worksheet, computers with Internet access

Overview

If a country has abundant arable land, does that mean it has high agricultural yield? What factors contribute to the productivity of the arable land? With world population exceeding 7 billion and increasing fast, food production is an essential issue. In this data-rich lesson, students will investigate how arable land, agricultural land, productivity and yield are distinct, inter-related concepts.

Objectives

- Students will visualize trends in population, arable land, and cereal yields.
- Students will read analytically to develop clear understanding.
- Students will describe how clear definitions are crucial to understanding data sets.
- Students will collect data, develop hypotheses, and draw inferences.

Teaching Tips/Activity Sequence

1. Introduce the activity briefly. Group students if you wish, hand out the student worksheet, and let students immediately start on Part 1. Have students stop after Part 1.
2. Discuss the answers to Part 1 and then lead the whole class in a discussion about arable land. Use the Teacher Resource document, "Define First, Then Quantify."
3. After the whole-class activity, allow students to work individually or in small groups to complete the rest of the activity.

Extensions

- Watch or listen to one of the stories about Egypt:
  - Egypt: Food for A Revolution: http://cironline.org/reports/egypt-food-revolution-2459
  - Egypt: Growing Pains: http://cironline.org/reports/egypt-growing-pains-3229
- Another lesson about agricultural techniques, "Nourishing the Soil" is available at http://ricediversity.org/foodfor9billion

- Investigate biomes , the history of agriculture , and Vavilov Centers. See http://www.hcs.ohio-state.edu/hcs300/biome.htm and http://www.plantsciences.ucdavis.edu/gepts/pb143/LEC10/Pb143l10.htm

Standards

National Science Education Standards Grades 9-12	*Common Core State Standards for Literacy in History / Social Studies, Science and Technical Subjects 6-12*
Science in Personal and Social Perspectives Natural Resources 3.2, 3.3	Reading Standards Key Ideas and Details RST1, RH1 Integration of Knowledge and Ideas RST7 Writing Standards Text Types and Purposes WHST2 Production and Distribution of Writing WHST4 Research to Build and Present Knowledge WHST9 Range of Writing WHST10

National Curriculum Standards for Social Studies	*National Geography Standards*
3. People, Places, and Environments 8. Science, Technology, and Society 9. Global Connections	2. Knows the location of places, geographic features, and patterns of the environment 9. Understands the nature, distribution and migration of human populations on Earth's surface 14. Understands how human actions modify the physical environment 18. Understands global development and environmental issues

Acknowledgements

Molly Holden and Susan Dodge, M.S. Ed for Creative Curriculum, produced these teacher notes and resources in conjunction with the "Food for 9 Billion" project (http://foodfor9billion.org), with funding from the National Science Foundation (PGRP grant #1026555; http://ricediversity.org) and Cornell University.

Arable Land and Food Production

Define First, Then Quantify

FOOD FOR 9 BILLION

Teacher Resource

*Note: This sheet is designed to guide a class discussion **following** Part 1.*

1. Introduce the discussion: In Part 1, we learned about different nations' populations and cereal crop yields. We need the cereal crops to feed people and animals. How do we get those grains? They're grown on land, but not all land grows grain equally well.

2. Direct students to quickly read http://www.alc.gov.bc.ca/alr/What_is_Ag_Land.htm for some background about agricultural land. *Note: The site is provided by British Columbia, Canada, and includes references to their rating system for land, which is largely irrelevant for the purposes of this lesson.* Review the article by prompting students with direct questions:

    a. What is agricultural land used for? *Agricultural land is not simply for food. The resource gives a very broad definition. The examples given are: "production of food for human and animal consumption…., growing of plants for fiber and fuels," as well as for making other products with the example of pharmaceuticals.*

    b. What determines whether land is suitable for agriculture? *Climate (moisture & heat or amount of sunlight), topography and the soil type all determine whether the land is will be productive agriculturally. The soil is important because different soils have different properties and characteristics; for example, two soils may provide different nutrients and hold different amounts of water.*

    c. Can aspects of the land or the crops be modified to make an area better for agriculture? *Yes, and this happens frequently. Using fertilizers is one example; fertilizers add extra nutrients to the soil. Different tilling methods also impact the nutrient levels in the soil. Note the sentence in the fourth paragraph: "Increasingly, new innovations in drainage and irrigation, tillage, nutrient replenishment (whether organic or inorganic), pest management, as well as closed environmental systems, allow for agricultural production on agricultural land once deemed too limited or unsuited for producing specific products."*

3. Go to the World Food Statistics map at http://cironline.org/reports/map-world-food-statistics-2971. Change the indicator in the pull-down menu to "Arable land" and ask students to explain some of the information the map tells them.
    a. Ask students to pay close attention to the name of the indicator and ask them what "Arable land" means. *Students might or might not know. The goal of this question is for students to realize that to understand the data, they need to understand the definition of the indicator. If you define your terms first, the numbers will make sense.*

4. Direct students to the World Bank site (http://data.worldbank.org/topic/agriculture-and-rural-development) and ask them to find the definitions for arable land and agricultural land.

   Arable land: *Land that has the correct amount of moisture and nutrients and is used to grow temporary crops. "Arable land (hectares per person) includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded."*
   (http://data.worldbank.org/indicator/AG.LND.ARBL.HA.PC)

   Agricultural Land: *Arable land, plus land used for permanent crops or for pasture for animals. "Land under permanent crops is land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber. This category includes land under flowering shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber. Permanent pasture is land used for five or more years for forage, including natural and cultivated crops."*
   (http://data.worldbank.org/indicator/AG.LND.AGRI.ZS)

   The differences might seem subtle, but they're important. It's also important to note that in the technical definition of arable land, some of the land might be temporarily unused, or fallow, and some of the crops that are grown might not be used for food

5. Direct students back to Part 2 on their handout to answer the question.

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Name: ____TEACHER ANSWER KEY_____

Date: _____ Class:_____

Arable Land and Food Production

People need to eat! Where does their food come from? As you already know, humans mainly eat other organisms: plants, animals, and some fungi and bacteria. Grains (the edible seeds of plants like wheat, rice, barely, corn, and others) form the basis for most people's diets. These "cereal" crops need plenty of land on which to grow. Does abundant arable land mean abundant food?

Part 1: Visualizing Trends

Use the World Food Statistics Map (http://cironline.org/reports/map-world-food-statistics-2971 to visualize trends about countries' food production capabilities.

1. Which countries have the largest populations? Do those same countries have the largest cereal crop yields? Use data to support your answer.

   The United States, China, India, Indonesia, Nigeria, Brazil, and Pakistan all have populations greater than 150 million, but they are not necessarily the countries with the greatest cereal crop yield. The US, Egypt, South Korea, New Zealand, and many countries in western Europe have high cereal crop yields (greater than 6000 kg/ha).

2. Which parts of the world have the lowest cereal crop yield?

   Many countries in Africa have very low yield. Yields are also low in most of the Middle East and parts of central Asia.

Part 2: Understanding the Land

After your class discussion, answer the following question: If we want to compare cereal crop yield to the amount of land used in its production, why should we use the arable land data rather than the agricultural land data?

Arable land represents land under temporary crops, temporary meadows for mowing or grazing, land under market or kitchen gardens, and land temporarily fallow. Agricultural land is arable land, plus land used for permanent crops or for pasture for animals. Cereal crops are temporary, because they need to be replanted every year. Therefore, arable land is the closest approximation of cereal crop area. Note that arable land will include data for more than just cereal crops, but it won't include extraneous data about land used for animals, orchards and more.

Name: ____TEACHER ANSWER KEY_____

Date: _____ Class:_____

Arable Land and Food Production

Part 3: Quantifying Trends, Developing Hypotheses, and Making Inferences
Use the World Food Statistics Map to collect the data, complete the tables, and answer the questions.

Table 1: Use the map to find the statistics for each country and complete the table.

Country	Population (in millions)	Arable Land (ha/person)	Cereal Crop Yield (kg/ha)	Fertilizer (kg/ha)
Egypt	*81.1*	*.04*	*7,635*	*723.6*
China	*1,338.3*	*.08*	*5,460*	*468.0*
Canada	*34.1*	*1.34*	*3,301*	*56.9*
Russia	*141.8*	*.86*	*2,279*	*15.9*
United States	*309.1*	*.53*	*7,238*	*103.1*

Table 2: Calculate the total amount of arable land in each country.

Country	Population (in millions) *From Table 1*	Population (written out)		Arable Land (ha/person) *From Table 1*		Total Arable Land (ha)
Egypt	81.1	*81,100,000*	x	.04	=	*3,244,000*
China	1,338.3	*1,338,300,000*	x	.08	=	*107,064,000*
Canada	34.1	*34,100,000*	x	1.34	=	*45,694,000*
Russia	141.8	*141,800,000*	x	.86	=	*121,948,000*
United States	309.1	*309,100,000*	x	.53	=	*163,823,000*

3. Using Table 2, determine which country has the most arable land and which has the least arable land.
   United States has the most arable land, and Egypt has the least amount of arable land.

4. Compare the total arable land available to the United States and to Egypt with their cereal crop yields.
   Egypt has less arable land, but a higher cereal crop yield per ha than the United States.

5. Using the data about fertilizer use from Table 2, create a hypothesis to explain a possible reason Egypt produces a higher cereal crop yield per hectare than the United States.
   Egypt uses approximately 7 times more fertilizer per ha than the United States. More fertilizer will create a higher cereal crop yield.

Name: ____TEACHER ANSWER KEY_____

Date: _____ Class:_____

Arable Land and Food Production

6. Use the data you have gathered to make an inference: Which county has the best land for growing cereal crops? Explain your answer with detail.
   The United States does not use as much fertilizer as China or Egypt, but has a very high cereal crop yield per hectare. This implies that the United States has more land that is naturally suited for growing cereal crops.

   What other information would you need in order to confirm your inference?
   You would need more information about the soil types used for growing cereal crops in different countries, as well as the amount and type of fertilizer used for cereal crops. Remember that arable land and fertilizer data include numbers for crops other than cereal, so fertilizer-intensive or unfertilized non-cereal crops could skew the data.

7. Explain two possible reasons for the differences in cereal crop yield that are not related to soil quality or fertilizer. What else in these countries might affect cereal crop yield?
   Differences in crop yield are often the result of irrigation or climate. Countries with higher yields could also be using improved crop varieties, more effective methods of planting and harvesting, more efficient machinery, or more effective fertilizer.

   Some countries with a lower yield may be using the arable land for something other than cereal crops. Different crops can vary greatly in the total weight produced per hectare.

8. It's also interesting to look at how yields have changed over time.
   a. Go to http://www.google.com/publicdata.
   b. Choose World Development Indicators
   c. On the right menus, choose Environment → Cereal Yield, and choose Sub-Saharan Africa and North America from the menu of regions. The graph should pop up on the right side.

   Use data to describe how the cereal crop yield in Sub-Saharan Africa between 1965 and 2010 compares to the yield in North America during that same time.

   Between 1965 and 2010, the cereal crop yield in Sub-Saharan Africa almost doubled, from 772 kg/ha to 1335 kg/ha in 2010. In North America, the yield almost tripled, from 2203 kg/ha in 1965 to 6342 kg/ha in 2010.

9. If a country needs food for its growing population, must that country have ample arable land in order to abundant grain? Explain your answer in a paragraph.
   Student answers will vary. Accept all that are reasonable and well developed. Domestic agriculture is an important source of a nation's food supply, but international trade is another. Grain is not the only food humans eat, but it is a staple.

Name: _____

Date: _____ Class:_____

Arable Land and Food Production

Does ample arable land equal abundant food? People need to eat! Where does that food come from? At it's most basic, as you already know, humans eat other organisms: mostly plants and animals, some fungi and bacteria. Worldwide, grains known as cereal crops – from plants like wheat, rice, barely, corn, and more – form the basis for most people's diets.

Part 1: Visualizing Trends

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2. Which continents have the lowest cereal crop yield?

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Arable Land and Food Production

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