FOOD SECURITY (HS)

Population growth

Focus question	How quickly has human population increased over time? What events have impacted the growth of human populations through time?
Learning target	Students analyze growth of human populations across time.
Vocabulary	Arable, infrastructure, carrying capcaity

LS2.A: Interdependent Relationships in Ecosystems

Performance expectation HS-LS2-1	**Classroom connection:** Students identify and describe factors (shown through mathematical representations) that affect carrying capacities of ecosystems at different scales by using human population growth from historical data.

Science and engineering practices

Using Mathematics and Computational Thinking	**Classroom connection:** Students use given mathematical and/or computational representations (e.g., trends, averages, histograms, graphs, spreadsheets) of ecosystem factors to identify changes over time in the numbers of humans in countries of different sizes.

Disciplinary core ideas

LS2.A: Interdependent Relationships in Ecosystems	**Classroom connection:** Ecosystems have carrying capacities. Students use mathematics and computational thinking to determine if humans have impacted the Earth's carrying capacity.

Cross-cutting concepts

Scale, Proportion, and Quantity	**Classroom connection:** Students analyze and use the given mathematical and/or computational representations i. To identify the interdependence of factors (both living and nonliving) and resulting effect on carrying capacity; and ii. As evidence to support the explanation and identify the factors that have the largest effect on the carrying capacity of an ecosystem for a given population

Background

According to most estimates, there will be over 9.5 billion people on the planet in 2050. Many experts suggest that growers will have to produce more food in the next 50 years than has been grown in the past 10,000, which would mean doubling current production on the same amount of land. Yield increases have begun to slow (see USDA graph: **nass.usda.gov/Charts_and_Maps/graphics/cornyld.pdf**). Therefore, this demand will require development of new technologies, new techniques, and new environmental practices.

What are the limits to food production possibilities? The amount of **arable** land may decrease if climates continue to change. Water is limited around the world and the places that are most productive are not necessarily in the areas where food is most needed. Fossil fuels, even with the addition of ethanol, run tractors while fertilizers and pesticides are also energy intensive to create. Therefore, food production is closely tied to fuel costs and availability.

Another concern is the **infrastructure** that is necessary to get food to markets before it spoils. In many less economically-developed countries, there is no system to get the food to market and storing it is not a viable option due to fungus and pests spoiling it. Soil is also vulnerable to erosion, desertification (once fertile land becomes arid), salinization (build-up of salts in the soil from over-irrigation), and water-logging (saturation of soil by groundwater).

One of the largest problems in the developed world is food waste. Some of the crop is lost in the field to pests (about 30%), some is left during the harvest (10–20%), and in the U.S., it is estimated that consumers throw away as much of 50% of their food. Population pressures are driving today's food production demand. While the need to feed a growing population will continue, factors such as decreasing infant mortality rates, reducing the need for children to work, providing women with educational opportunities and access to family planning will improve the standard of living in countries worldwide and increase the demand for food. With 9 billion eaters, the agriculture industry, made up of large-scale farmers, local food producers, entrepreneurs, agricultural scientists, and engineers will all become allies in meeting future food demands.

Prior knowledge

Students will need to know how to graph data using a proper scale for years and billions. A line graph is most appropriate for population data, but a bar graph or histogram will show a relationship, just not the growth between the years.

Materials

Students will need an electronic device to access the internet.

Procedure

Students will work individually to complete the following steps.

1. Have students research the information by visiting **worldpopulationhistory.org/map/2050/mercator/1/0/25/**. Ask:
   - How many years has it taken for the world population to double?
   - How many years has it taken for the world population to increase by 1 billion?

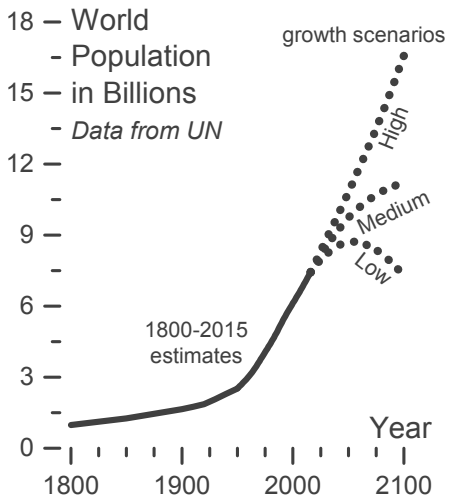
2. Students create their own table or use the example table to collect data on the years it has taken to reach each billion and to double.

Year	Population in billions	Number of years between	Years to double
1804	1 billion	many	
1928	2 billion	124	124
1960	3 billion	32	
1974	4 billion	14	56
1987	5 billion	13	
1999	6 billion	12	
2011	7 billion	12	
Estimated 2023	8 billion	Estimated 12	Estimated 49

Differentiation

Other ways to connect with students with various needs:

- **Local community:** students may investigate the population changes in their town, city, state, or home country. (**census.gov** to access local data)
- **Students with special needs (language/reading/ auditory/visual):** Teacher may supply a graph for students to interpret or require only the mathematical calculation without the graph.
- **Extra support:** students may model exponential growth by using objects (seeds, blocks, etc) to show rapid increase as numbers increase, or complete pedigrees of their own families from grandparents to their own generations. (ties to local community also)
- **Extensions:** Students can compare birth rates from previous decades to see the change over time and how the growth rate has slowed, but how the numbers are still adding up exponentially.



Possible graph
commons.wikimedia.org/wiki/ File:World_population_v3.svg

Student handout

Reflection

1. What might account for the decreasing time between billions?

Possible answers: more people to have children, increased life span and lower infant mortality

2. How have humans utilized **arable** land resources to increase food production to allow for these increases?

Possible answers: better farming methods, use of technology, cleared more land from forests

3. What are the effects of **infrastructure** improvements and technology when used in food production?

Possible answers: increased yield, more efficiency by reducing time (using tractors and harvesters), less labor needed

4. What events or factors have affected human population growth and carrying capacity of ecosystems?

Possible answers: war (WWI, WWII), disease (Black Death), advances in technology

5. What factors must be considered to project future growth?

Possible answers: cultural factors, limits imposed by governments, number of women of childbearing age, age at marriage, education of women, child mortality rates (the higher the mortality rate, the higher the rate of population increase), women in the workforce

Assessments

Ask students to begin an answer to the following question: *Have human populations impacted carrying capacity?* Write a paragraph to:

- Identify the factors that have the largest effect on the carrying capacity of an ecosystem for a human population, and
- Identify any interdependence of factors (both living and nonliving) and the resulting effect(s) on carrying capacity; use evidence to support your explanation.

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Uses mathematical and/or computational representations of phenomena or design solutions to support explanations.	Carrying capacity is defined, but not used correctly. Two factors are listed as interdependent factors.	Carrying capacity is defined correctly in paragraph. Two or more factors (either living or nonliving) are listed and the impacts they have on carrying capacity of human populations are explained.	Carrying capacity is defined and used appropriately to describe the impact of humans on the scale of a single ecosystem up to the Earth. Two or more factors (either living or nonliving) are listed and the impacts they have on carrying capacity of human populations are explained and evidence is given for the factor with the largest impact.

Rubric for self-assessment

Skill	Yes	No	Unsure
Carrying capacity is a concept I understand and I can explain and apply the concept to human populations.			
I used mathematical or computational thinking to provide evidence to answer the question: Have human populations impacted carrying capacity?			