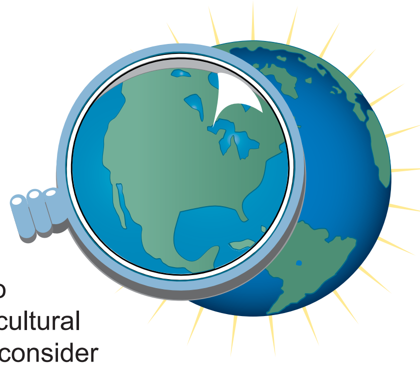
Who will feed the world?



Investigation Overview

Investigation 3 focuses on meeting the food needs of an increasing global population. Students work in groups to investigate population growth and agricultural production in major world regions and consider how developments in technology and monitoring systems will address these concerns in the future. The investigation concludes with an investment challenge in Mozambique. Students work in groups to make recommendations for improving agricultural production in this country.

Time required: Four to eight 45-minute sessions (as follows):

Introduction and Part 1: One or two sessions
Part 2: One or two sessions
Part 3: One session
Part 4: One or two sessions

Materials

A copy of Investigation Briefing and Log for each student. The key to the Log is included in this Educator's Guide.
Computer with a CD-ROM drive. The Mission Geography CD contains color graphics needed for this activity.
World atlases
Optional: Access to the Internet, which offers opportunities for extending this activity.

Content Preview

Investigating food production involves a number of topics. First, an increasing global population will continue to put pressure on world regions to increase agricultural production to meet demand. Population growth is centered in the developing world regions including Asia and Oceania, Latin America and the Caribbean, and sub-Saharan Africa. Measuring agricultural production in relation to population growth puts sub-Saharan Africa in the most tenuous position, as per capita (per person) food production declined 12 percent between 1965 and 1985. Increasing agricultural production will involve a variety of techniques including satellite measurements of vegetation growth. Additionally, investing in certain types of crops will play a key role in meeting human demand.

Geography Standards

Standard 1: The World in Spatial Terms

How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information

- Produce and interpret maps and other graphic representations to solve geographic problems.

Standard 5: Places and Regions

That people create regions to interpret Earth's complexity

- Use regions to analyze geographic issues and answer geographic questions.

Standard 9: Human Systems

The characteristics, distribution, and migration of human populations on Earth's surface

- Predict trends in spatial distribution of population on Earth, and analyze population issues and propose policies to address such issues.

Standard 14: Environment and Society

How human actions modify the physical environment

- Evaluate the ways in which technology has expanded the human capacity to modify the physical environment.

Standard 18: Uses of Geography

How to apply geography to interpret the present and plan for the future

- Use geography knowledge and skills to analyze problems and make decisions within a spatial context.

Geography Skills

Skill Set 4: Analyzing Geographic Information

- Make inferences and draw conclusions from maps and other geographic representations.
- Use the processes of analysis, synthesis, evaluation, and explanation to interpret geographic information.

Classroom Procedures

Beginning the Investigation

1. Hand out a **Briefing** and **Log** to each student and have them read the **Background** section. Draw out discussion with such questions as:
   Do you think hunger and famine will be eliminated during your lifetime? Why or why not?
   What do you think Secretary Glickman meant by his statement about an "unstable food supply"?
   What do you see as the difference between increasing food production *and* increasing food availability?
   What is meant by "agricultural sustainability?" Why do you think this is an important idea?

2. Tell students that they will work in regional teams in the first part of this activity and that they will conclude by making group investment decisions for stimulating agricultural production in Mozambique.

Developing the Investigation

3. Have students read the **Objectives** and take any questions they may have.

4. Leaf through the materials with students and point out the <u>underlined Log questions</u> to be answered on the Investigation **Log** at the end of the materials. The key to the **Log** is found at the end of this Educator's Guide. Give students a schedule for completing the **Log**.

5. Direct attention to the **Scenario: Planning to feed world regions** section. Divide the class into six teams roughly equal in size. Each team is to represent a major world region. The six world regions are listed in Table 2. Emphasize the importance of studying and discussing the materials as a team and of working on team answers to the **Log** questions.

   <u>Alternative</u>: If you prefer smaller teams, you may wish to form two teams for each region. To have students appreciate the differences in population between these regions, you might ask them to compute the proportional representation of the teams using the "Percentage of World Population" column in Table 1. For example, 55 percent of the students would represent Region 4, and 4 percent would represent Region 3. You might even use these proportions to form teams, but that would give you teams of very uneven sizes.

6. Have teams meet to locate their world region on a map and to identify the countries that comprise their region. Have teams share this information with the entire class.

7. Set students working through the materials, beginning with **Part 1: How do the populations of world regions compare?** Direct attention to Table 1, which marks each year the global population increased by 1 billion. Have students add a column to Table 1 by calculating the number of years between the next billion increment. There will be eight entries:

Growth from:	
1 to 2 billion	130 years
2 to 3 billion	30 years
3 to 4 billion	15 years
4 to 5 billion	12 years
5 to 6 billion	12 years
6 to 7 billion	13 years
7 to 8 billion	14 years
8 to 9 billion	17 years

   Assist students in graphing this table at Question 1 on the **Log**.

8. After the regional teams have worked through **Part 3**: **What is the need for increasing agricultural production?**, they should begin on **Part 4: Investing in Mozambique**. Be sure students understand that Part 3 demonstrated that of all the major world regions, sub-Saharan Africa will have the hardest time producing enough food to meet demand. As a result, Part 4 will focus on Mozambique as a case study to investigate how agricultural production can be increased.

   Students can stay in their assigned groups, but they are no longer representing a major world region. Instead, they should pretend to be part of a FAO team investigating how to increase food production in Mozambique. The first section will ask them to estimate the cropland use intensity (CUI) value for 1973, 1992, and 1995 using Figures 8, 9 and 10. Students should make estimations based on the percentages given in the figures. It is not critical that they get the exact answers; rather, they should understand that the CUI is currently very low for Mozambique.

Students should continue to work in their groups and have an opportunity to complete their major task: making investment decisions for the agricultural sector. Students are given the task of investing $40 million in a variety of agriculture and fishery sectors to improve production in the country to 90,000,000 tonnes. Investments must be made in multiples of $5 million, and students can invest as their team desires, but they must support their decisions on Log Question 9. Students will need some guidance with this part of the investigation as Table 5 provides some steering information on the value of these investments as either a source of consumption or foreign exchange. Table 5 presents these as multipliers, which students can utilize to make investment decisions. They should multiply their investment by the value of the multiple, and then multiply this again by the production increase in tonnes to determine the investment outcome. Remind students that they want to invest for both consumption and foreign exchange. Point out that the foreign exchange earned by exporting crops can be used for consumption or to buy food on the international market. Students should also be encouraged to diversify in order to assist in protecting against harmful pests or bad weather that might destroy a single crop.

9. Have teams report their investment recommendations and reasons to the whole class, and have the class discuss, classify, and evaluate these recommendations according to agreed upon criteria, such as importance, practicality, agreement with facts, etc.

Concluding the Investigation

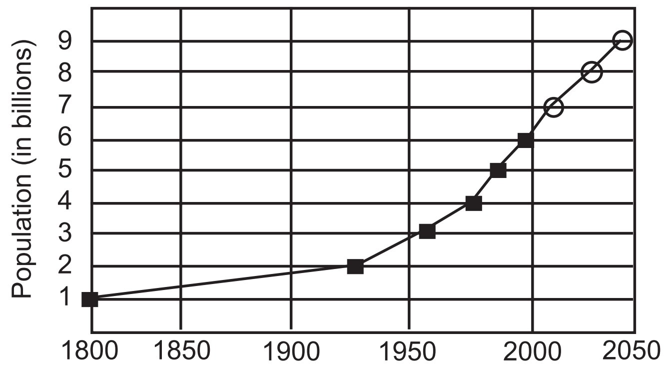
10. Debrief the investigation by discussing the Log questions. You may wish to debrief the activity even further by referring to the **Objectives** listed at the beginning of the **Briefing**.

Evaluation

Evaluate the Logs using the answers in this Educator's Guide. You may wish to provide your own guidelines for the team investment reports, or you may simply ask for a numbered list of recommendations.

Log

1. The graph of Table 1 should look like the following:



This is a classic J-curve of population growth with very little growth, then growth increasing at greater and greater rates (reflecting exponential growth) shown by a steeply rising curve, and finally, growth beginning to slow as seen in the flattening of the curve when the population is very large.

2. Using Figure 2, compare and contrast the diet in your region with the other regions.
This will depend on the student's choices of which foodstuffs to emphasize. Use Figure 2 to guide your assessment of their answers.

3. How do you explain these differences in diets?
Diets around the world vary a great deal due to the availability of certain foodstuffs. For example, people in the developed world can afford to eat livestock products and fats more regularly than people in developing countries. Food production also contributes to variation in diets, as well as differences in food preferences.

4. Compare and contrast the dietary energy supply levels in your region with the other regions. Specifically, name the countries (and their levels) in your region that have the highest and the lowest dietary energy supplies, and compare and contrast these with other countries with very high and very low levels.
As with Question 2, this answer depends on the students' choices of which countries in their region to emphasize. Use Figure 3 to guide your assessment of their answers.

5. With your team, brainstorm a list of reasons that might account for the variations in dietary energy supply levels between regions and countries and within countries.
   - *Varying capacities to purchase food (people in richer countries can afford more livestock products and fats, for example)*
   - *Different availability of foods among countries*
   - *Diets of richer countries usually more balanced nutritionally and also contain a greater proportion of protein, particularly of animal origin, than those of the poor countries*
   - *Developing countries' diets characterized by a higher proportion of cereals*
   - *Significant variations in diet among countries reflecting differing production capabilities, access to food types, and tastes even for countries at similar income levels*

6. According to Figure 6, which regions in Africa have "very poor vegetation"? Why do you think this is so?
   Northern Africa has very poor (or sparse) vegetation because of the climate and physical landscape. The Sahara Desert and the Sahel characterize this region, which has little to no rainfall on a regular basis. In the southern portion of Africa, the Kalahari and other deserts limit the amount of vegetation growth.

7. According to Figure 6, which regions in Africa have shown "improvement" in their vegetation growth?
   There are a few locations that have shown improvement in vegetation growth. Southern Africa, parts of South Africa, Botswana, and Namibia, have demonstrated improvement. Additionally, there has been improvement in parts of central Africa and in western Africa near the Ivory Coast.

8. Estimate the cropland use intensity (CUI) for 1973, 1992, and 1995. How does this information assist your group in understanding agricultural production in Mozambique?
   The CUI maps (Figures 8-10) showed that 22 percent of the land was cropped before independence (1973). The CUI dropped to 5 percent by the end of the civil war in 1992 and rebounded to 17 percent by 1995. This information is helpful for a number of reasons. First, it allows agricultural agencies to identify the current state of agricultural intensity in the country. All of these estimates are very low, indicating that greater investment in the agricultural sector is needed. Secondly, the CUI allows for an assessment of where agriculture is currently practiced within the country. This is extremely useful for determining which locations require future investments.

9. Put your group investment recommendations for the $40 million in the table, and explain why you are investing this way.
   Students should complete the table in the Log to get an investment return of 90,000,000 tonnes or higher, which was their investment challenge.

   The investment decision that results in the highest production value is investing all $40 million into maize or rice (resulting in a return of 120,000,000 tonnes of maize or rice). This is not the most ideal investment, however, because it forces the country to rely on only one crop. This could be disastrous if certain types of weather or pests destroy the crop. Students should try to balance investments in maize with rice and fishery products that are a valuable source of foreign exchange. In evaluating their answers, however, it is more important that students support their decisions. Choosing to invest in crops, rice and maize for example, is important for food security. On the other hand, students may choose to invest in crops that are a source of foreign exchange for the country. In this case, investing in nuts or fisheries would be logical.

Module 2, Investigation 3: Briefing
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Background
More than one billion of today's six billion people suffer from hunger. How many will be hungry when the world's population doubles, as it is expected to do by the end of the 21st century? Or is it possible that hunger and famine will be eliminated in this century? Whether or not there will be enough food is a matter of speculation, but we can be certain that feeding the world will be a huge challenge. It will affect all regions of the world and all economic, political, social, and environmental systems. As former U.S. Secretary of Agriculture Dan Glickman said, "An unstable food supply is the greatest threat to our national security" (Smith 2000:14). Experts believe that it is crucial that we increase both food production *and* food availability to needy populations. If this can be done, we will also need to achieve agricultural sustainability—that is, to protect the environment against degradation from increased agricultural production. In this activity, you will investigate global food production and hunger. Additionally, you will examine sub-Saharan Africa to consider the ways that famine might be alleviated in the future.

Objectives
In this investigation, you will
- compare population growth and nutritional levels of world regions,
- consider the demands of increasing global population upon food production,
- learn that food security requires both a food supply and access to that supply,
- consider the role of industrial agriculture in feeding the developing world,
- examine ways that technology can help to prevent famines, and
- make investment decisions to stimulate agricultural production in sub-Saharan Africa.

Scenario: Planning to feed world regions
Imagine that you are a geographer working for the United Nations Food and Agriculture Organization (FAO). You have recently been assigned to a team of scientists investigating food and population issues in a major world region. Use Parts 1 and 2 of this investigation to help you assess, and report to the entire group, the status of population and food production in your region.

Part 1. How do the populations of world regions compare?

Understanding world hunger requires an analysis of the changing global population. To appreciate how the global population has changed, look at Table 1, which lists the years when the world's population reached an additional billion.

Table 1: Years when world population reached an additional billion

Population	Year
1 billion	1800
2 billion	1930
3 billion	1960
4 billion	1975
5 billion	1987
6 billion	1999
7 billion (estimate)	2012
8 billion (estimate)	2026
9 billion (estimate)	2043

Sources: U.S. Bureau of the Census 1998; Population Reference Bureau, Inc., 1999

As you work through this investigation, you should answer the underlined questions on the Investigation Log. <u>For Question 1, make a line graph of the world's population from 1800 to 2043</u>.

Nearly all of the population increase in the 21st century will occur in the poorer, developing regions of the world, specifically Africa, Asia (except Japan), Latin America and the Caribbean, and Oceania. By comparison, populations in the industrialized, developed countries will remain relatively constant (Figure 1).

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Who will feed the world?

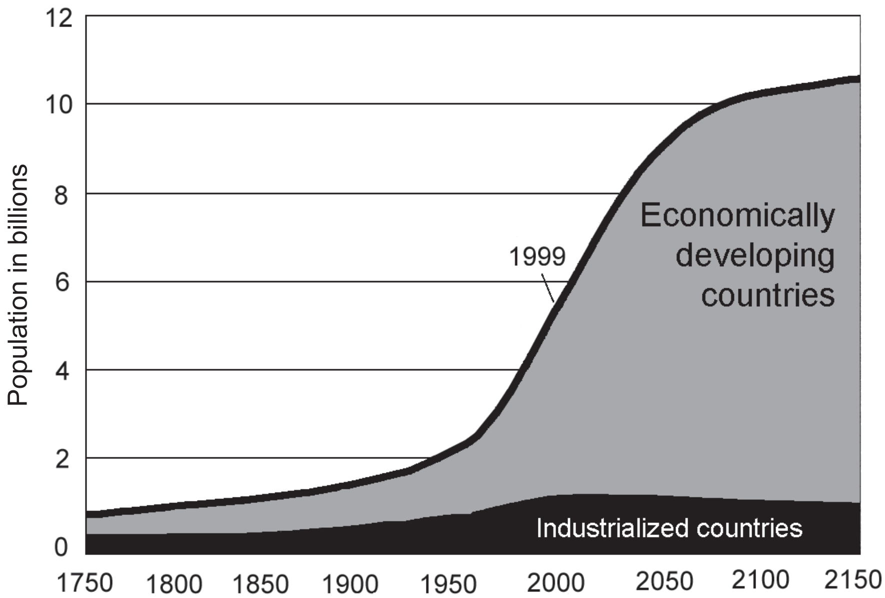

Figure 1: World population growth, 1750-2150 (population after 1999 is estimated)

Sources: The World of Child 6 Billion. 1999. Washington, D.C.: Population Reference Bureau and National Peace Corps Association. http://www.prb.org and http://www.rpcv.org

Table 2: Regional contribution to world population and world population increase in 1998

Region	Percentage of World Population	Percentage Contribution to World Population Increase
1. Eastern Europe and Newly Independent States	9	1
2. Sub-Saharan Africa	10	20
3. Near East and North Africa	4	9
4. Asia and Oceania	55	57
5. Latin America and the Caribbean	10	10
6. Industrialized Countries (U.S., Canada, Western Europe, and Japan)	12	2

Sources: U.S. Bureau of the Census, 1998

The current contributions to world population by rich and poor regions can be seen in Table 2. Use the table to assess the population growth in your region.

Part 2. How do the diets of world regions compare?

Food is divided into many types, including animal oils and fats, milk and eggs, sugars, roots and tubers, and cereals. Each region has a different proportion of types of food in its diet (Figure 2). For example, Figure 2 shows that, in Latin America and the Caribbean, cereals make up 40 percent of the diet, and in East and Southeast Asia, 60 percent of the diet.

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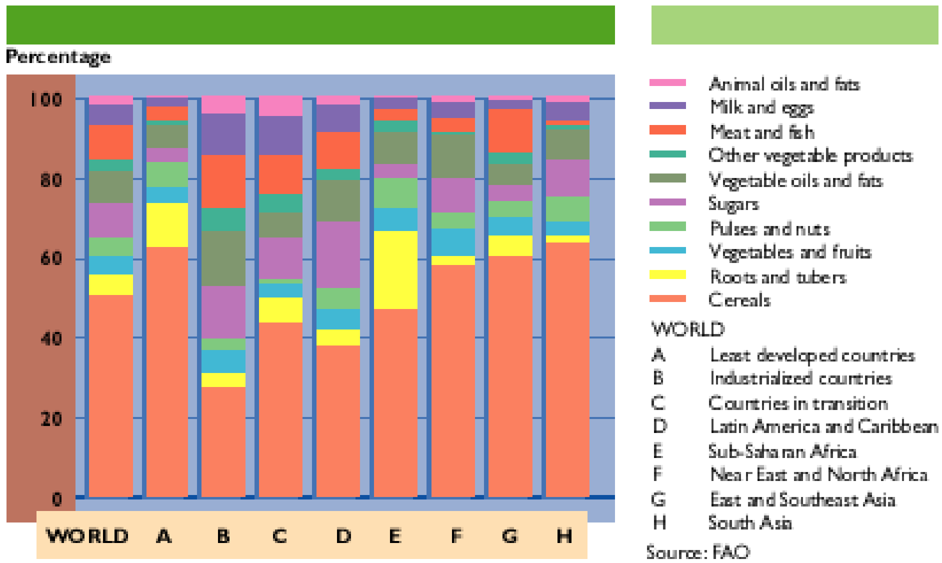

Figure 2: Share of food groups by region and country

Source: United Nations Food and Agriculture Organization 1998,
The State of Food and Agriculture 1998: FAO Agriculture Series No. 31,
http://www.fao.org/docrep/w9500e/w9500e03.gif

Use Figure 2 to determine what types of foods contribute to diet in your world region. (In reading Figure 2, teams assigned to Region 1 should use column C; Region 4 uses columns G and H; and Region 6 uses column B.)

You can use the information from the Log questions to help your team develop its recommendations. <u>Answer Log Questions 2 and 3.</u>

About 840 million people in the developing world suffer from malnutrition (Table 3). With less than 2,000 calories per person per day on average, about 15 percent of Earth's people live a life of permanent or intermittent hunger (Conway 2000). Malnutrition is particularly devastating

Table 3: Malnutrition in developing regions in 1998

Region	Number of Malnourished People (in millions)	Percentage of Population Malnourished
2. Sub-Saharan Africa	215	43
3. Near East and North Africa	37	12
4. Asia and Oceania	524	18
5. Latin America and the Caribbean	65	15

Source: United Nations Food and Agriculture Organization, 1998 to the young and elderly. Malnutrition weakens the body's immune system to the point that common childhood ailments, such as measles and diarrhea, are often fatal. Each day, 19,000 children die as a result of malnutrition and related illnesses (Brown 1999; World Food Summit 1996).

In contrast with developing regions, in some of the countries in Region 1 (Eastern Europe and Newly Independent States) and Region 6 (the industrialized countries—Japan, U.S., Canada, and Western Europe), over half of all adults are medically overweight (Gardner and Halweil 2000). This condition occurs when food energy intake exceeds energy use, which contributes to the risk of death from high blood pressure, coronary heart disease, stroke, diabetes, and various forms of cancer. As can be seen from the global distribution of dietary energy supply levels (Figure 3), the people in some regions are overfed and in others they are underfed.

Figure 3 is a map of the countries of the world and their average per person dietary energy supply, measured in kilocalories (kcal) per day. Use Figure 3 to determine the dietary energy supply levels in your world region, and answer Log questions 4 and 5.

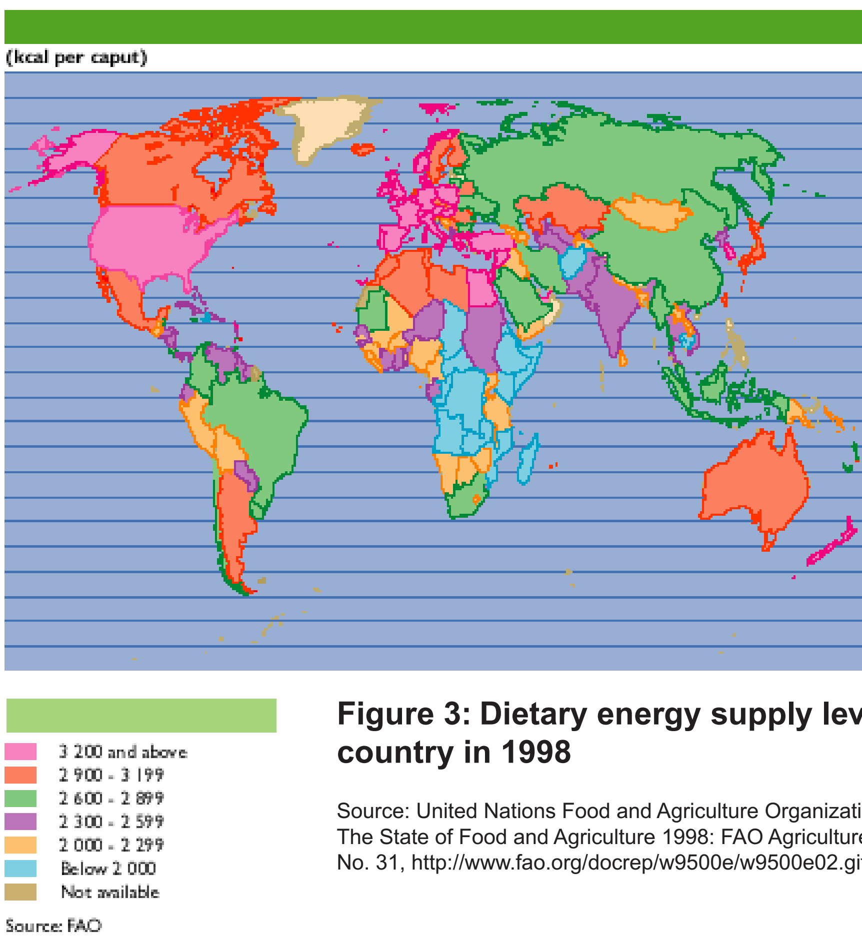

Figure 3: Dietary energy supply levels by country in 1998

Source: United Nations Food and Agriculture Organization 1998, The State of Food and Agriculture 1998: FAO Agriculture Series No. 31, http://www.fao.org/docrep/w9500e/w9500e02.gif

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Part 3. What is the need for increasing agricultural production?

Throughout the 1970s, the world watched in horror as numerous African countries suffered through droughts that led to massive famines. The images sent around the world (Figure 4, for example) only emphasized the belief that there wasn't enough food to feed the increasing global population. Although scientists have argued that famines are often caused by peoples' **lack of access to food** (access is blocked, for example, by low incomes, political conflicts, and wars), as opposed to a **shortage of food** (Sen 1981), most agree that the amount of food must continue to increase in the future to meet the demands of increasing populations.

Figure 4: Refugee camp in Africa

Source: United Nations Food and Agriculture Organization, 1998, http://www.fao.org

Following large increases in global agricultural production from the Green Revolution, we still need to increase the amount of food produced. In fact, yields for cereals in the developing world decreased in the period 1985-94, following the peak Green Revolution yields (Figure 5). This recent decrease in rice, wheat, and maize yields is an even larger problem when population growth is considered.

Agricultural systems will be challenged in the future, as rising population levels will put pressure on their capacity to meet human demand. These pressures will be felt most where population growth is highest and incomes are lowest. This formula points to Africa, especially the sub-Saharan region, as the area with the greatest problem. A rapidly growing population in Africa will demand increases in agricultural output. Between 1965 and 1985, total food production grew in sub-Saharan Africa by 54 percent, but *per capita* food production declined by 12 percent (Turner et al. 1996).

You may have learned from the **Industrial Agriculture** investigation in this module that at the beginning of the 20th century, each American farmer produced enough food to feed seven other people in the United States and abroad, but at the beginning of the 21st century, a U.S. farmer feeds 96 people (Brown 1999). This staggering fact resulted from the use of new technologies for planting, cultivation, and harvesting; irrigation and chemical fertilizers; and plant breeding and improvements, especially in wheat, rice, and corn. Wheat and rice are consumed largely by humans, but most of the world's corn harvest is fed to livestock and poultry (Brown 1999).

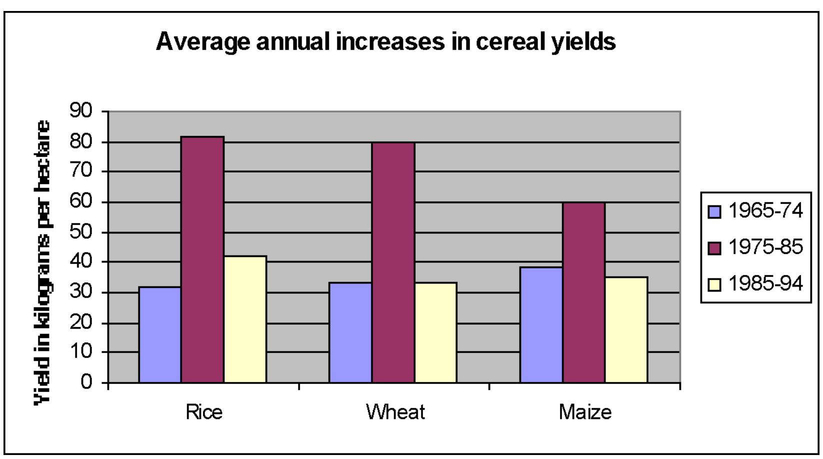

Figure 5: Cereal yields in developing countries from 1965-1994

Source: Conway 2000: 13

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These technologies have produced enormous grain surpluses, especially in the United States, Canada, Europe, Australia, and Argentina. Many developing countries have been forced to buy these surpluses to help feed their rapidly growing populations. They often pay for these food grains with nonfood cash crops they grow such as coffee, tea, sugar, and cotton. Solutions to feeding the rapidly growing populations in the developing world must consider industrial agriculture, along with other strategies, to increase agricultural production.

Another part of the solution may involve the use of new technologies to reduce the chance of famines brought on by environmental fluctuations. For example, NASA satellite data, which are used to study the expansion and contraction of the deserts and semiarid lands of Africa, are the principal source for providing early warning of potential famines around the African continent.

Since 1987, scientists at NASA's Goddard Space Flight Center (GSFC) in Greenbelt, Maryland, and the U.S. Agency for International Development (USAID) have been cooperating on a project to provide data to USAID's Famine Early Warning System (FEWS). They seek to understand natural variations of climate that relate to desert boundaries and adjacent semiarid areas, and to determine any changes in climate between 1980 and 2000 (Dunbar and Kenitzer 1993).

As Dr. Compton J. Tucker, a scientist in the Laboratory for Terrestrial Physics at Goddard, states:

> The Agency for International Development of our State Department came to us after seeing some of our publications on remote sensing of the Sahel of Africa and indicated it was interested in studying the famine stricken regions in Africa. Since we use satellites to look at vegetation in these regions, we can obtain data on countries that historically have been affected by famine and do so very close to real time.

Using daily data from the National Oceanic and Atmospheric Administration (NOAA) -7, -9 and -11 meteorological satellites, scientists measure the density of green vegetation in a specific region every 10 days. As Tucker states:

> Since 1981, we have compiled a time series of plant-growth histories for the entire continent of Africa, and we use it to assess current and future vegetation growth. This information is used by USAID's FEWS to determine where droughts are occurring, their severity, and how widespread they are.

USAID's FEWS augments the satellite data with meteorological information and socioeconomic information, where available, to determine the location and severity of drought in Africa, Tucker said. When drought conditions are detected, a FEWS team can begin coordinating relief efforts, if required. For example, changes in vegetation can indicate oncoming drought. Figure 6 shows a series of satellite vegetation models for the African continent. The *Normalized Difference Vegetation Index* (NDVI) is a measure of the greenness of the vegetation, which is used to generate assessments and make predictions. The first image is the NDVI taken during January 1-10, 2000. The second image (vs Previous) is a comparison of the first image to previous years. Finally, the third image (vs Average) is a comparison of the first image to the average NDVI for the continent.

NASA research and USAID's FEWS are examples of how improvements in technology will contribute to agricultural productivity in various regions of the world. At the very least, having more data on vegetation growth and precipitation patterns should assist in reducing the chance of famines on the African continent.

<u>Answer Questions 6 and 7 on the Log.</u>

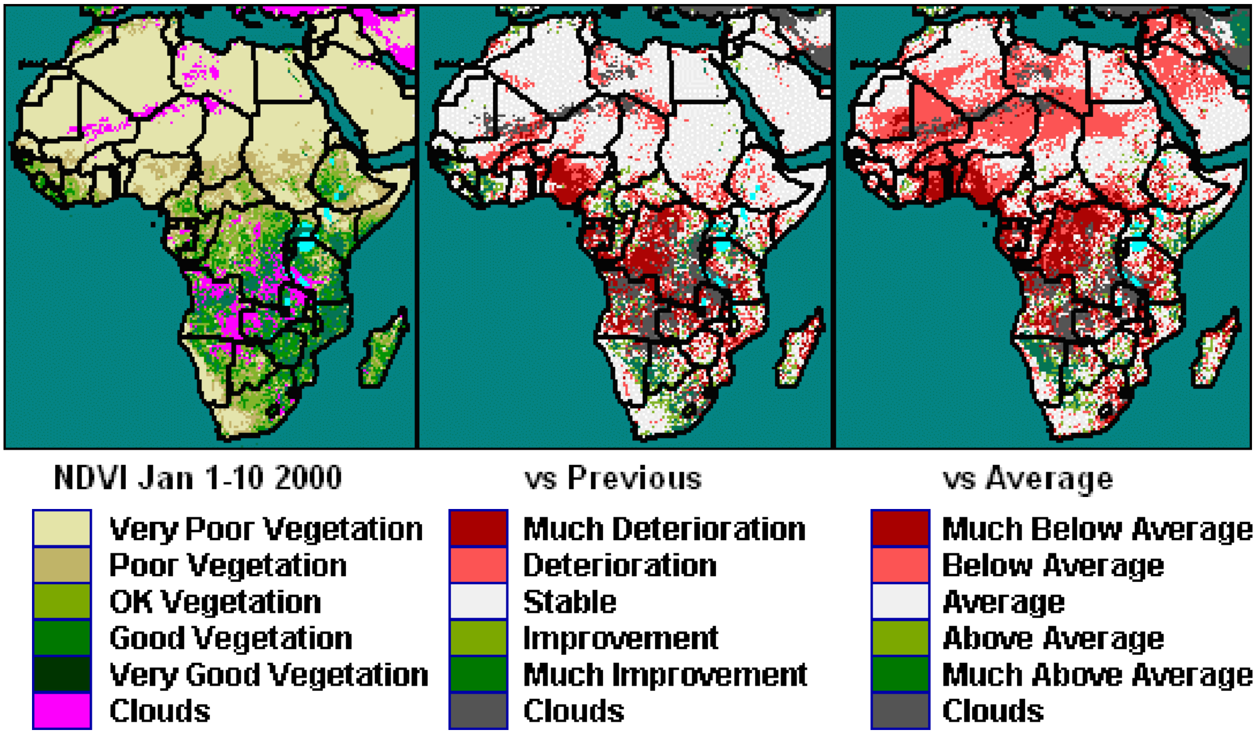

Figure 6: Satellite vegetation analysis for Africa

Source: USAID Famine Early Warning System, 1999, http://www.info.usaid.gov/fews/imagery/sat_afr.html

Part 4. Scenario: Investing in Mozambique

Since sub-Saharan Africa faces the greatest challenge for increasing agricultural production to meet a growing population, this section addresses a specific sub-Saharan country. Continue to imagine that you are a geographer working for the United Nations Food and Agriculture Organization (FAO). Your team has been given the task of investing $40 million to stimulate food production in Mozambique, one of the poorest countries in sub-Saharan Africa. Mozambique is located in southern Africa and has been significantly affected by colonialism and war. Mozambique was a colony of Portugal until 1975, when an 11-year war of independence ended with the establishment of an independent, Marxist government. But a 17-year civil war started soon after independence, with an internal military uprising that was supported by some foreign governments.

The civil war affected the people of Mozambique severely, especially in rural areas. Hundreds of thousands of people were killed. Over a million people fled the country, especially to Malawi, and more than a million others were displaced within Mozambique (Sill 1992). Many rural people migrated to the cities and the coast where the government maintained control. The country went into severe economic decline and agriculture was disrupted, so the country could not feed itself. By the late 1980s, Mozambique had one of the lowest per-capita caloric intakes in the world (Sill 1992).

USAID and FEWS have been active in Mozambique for a number of decades. As you learned earlier, FEWS utilizes satellite images to determine the health of vegetation in certain areas. Figure 7 shows maps of the NDVI for southeastern Africa comparing the average with conditions in 1991.

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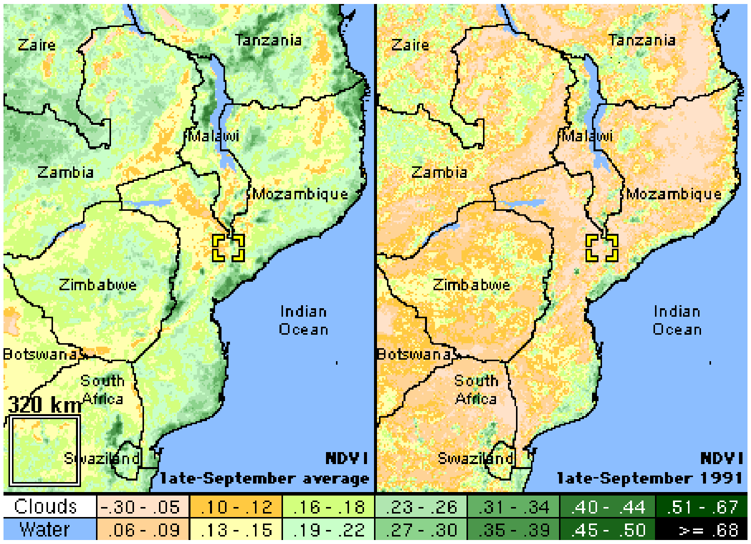

Figure 7: NDVI maps of southeastern Africa, including Mozambique

Source: http://edcwww.cr.usgs.gov/earthshots/slow/Mozambique/Mozambique
Note: This is animated at the above site, so you can observe the changes over the course of one year.

In 1995, three years after the war ended, USAID asked the U.S. Geological Survey (USGS) to document the migration of rural Mozambicans during the civil war using LANDSAT and other satellite data. In areas of subsistence agriculture, cropland use intensity (CUI) approximates population density. CUI can also be used to connect agricultural statistics with specific geographic locations. For example, if Sofala Province reports a 50 percent rise in planted grains, CUI can identify where in the province the grains were planted.

Utilizing the CUI can assist your group in deciding how to invest in Mozambique because you can assess the current state of agriculture in the country. Using the process outlined above, a small part of Mozambique was mapped five different times, representing various stages in the civil war. The CUI for 1973 is represented as Figure 8 below.

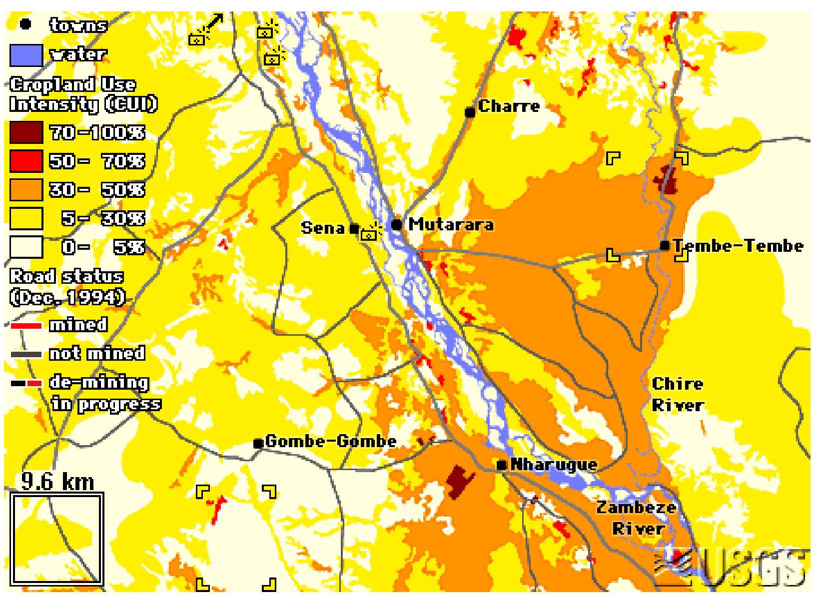

Figure 8: Estimated CUI in 1973

Source: http://edcwww.cr.usgs.gov/earthshots/slow/Mozambique/Mozambique

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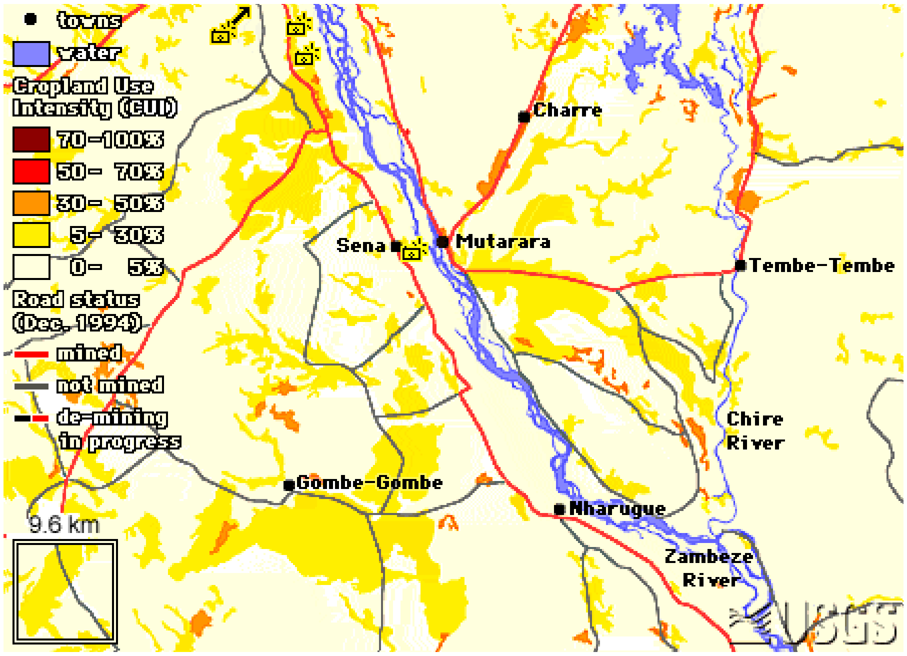

Figure 9: CUI in 1992

Source: http://edcwww.cr.usgs.gov/earthshots/slow/Mozambique/Mozambique

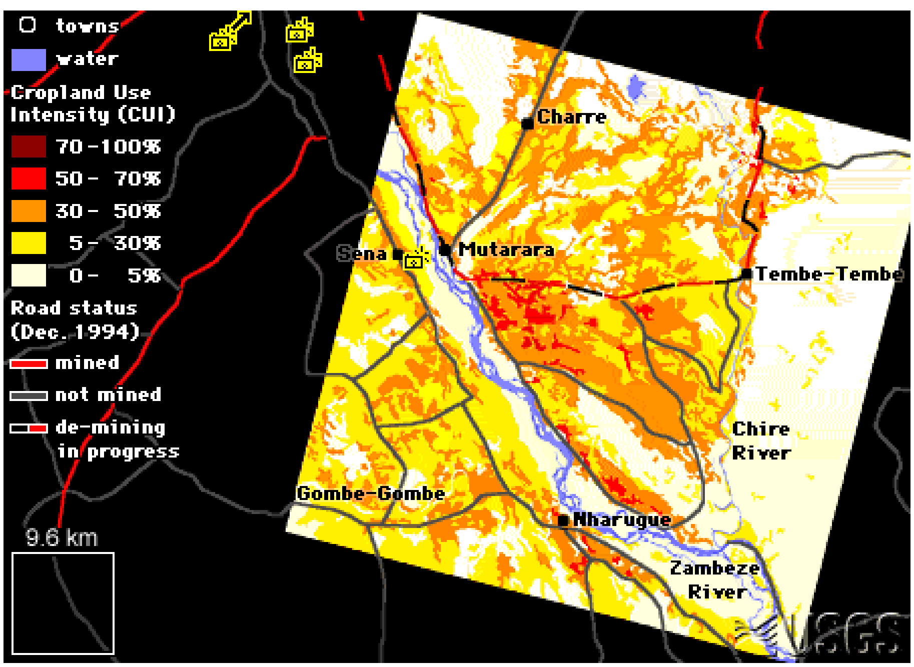

Figure 10: CUI in 1995

Source: http://edcwww.cr.usgs.gov/earthshots/slow/Mozambique/Mozambique

The satellite images of the CUI in 1992 and 1995 are represented as Figures 9 and 10.

Begin your task of investing in Mozambique by estimating the CUI from 1973 to 1995. Answer Question 8 on the Log.

Obviously, there is still a pressing need to increase agricultural output in Mozambique. Your team needs to determine how to invest the $40 million in the agricultural sector. In 1996, Mozambique had 20 million hectares of arable land, of which 10 percent was cultivated (Turner 1999).

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Table 4 is a breakdown of the major products in the agricultural sector. The fishery sector is also included, since this sector plays a key role in meeting food needs in the country.

Your challenge is to invest $40 million and increase the total food production to 90,000,000 tonnes. You can invest the money however you want in allotments of $5 million. Include an explanation for your investment decisions.

As you invest, think about which crops are better for consumption and which crops are a better source of *foreign exchange* (money a country makes from its exports). Remember that the money a country earns from exporting crops can be used to invest in crops for consumption or to buy food on the international market. Table 5 provides some information on the value of these crops as a source of domestic consumption and as an export product for foreign exchange. The multiples indicate the total return that an investment in a particular crop produces. That is, some crops respond to increased investment much more than others. To determine your return on investment, multiply your investment by the multiple value. You should then multiply this value by the production increase per $1 million investment found in column 1, page 14 of your student log to determine the change in agricultural production as a result of your investment. As you invest, your group should balance the need to increase production for consumption with the need to invest in products for foreign exchange.

<u>Use the table in the Log at Question 9 to list your investments.</u>

Table 4: Agriculture and fishery production in Mozambique

	Current Production (tonnes)
Type of agriculture	
Maize	1,246,000
Rice	186,000
Other grains	387,000
Cassava	5,553,000
Beans	189,000
Peanuts	147,000
Type of fishery product	
Anchovies	300,000
Prawns and shrimp	14,000

Sources: Turner, 1999; Mozambique Agricultural Statistics, http://www.ine.gov.mz/sector1/agricu.htm

Table 5: Estimated multiple values for consumption or foreign exchange

	Value for Domestic Consumption as Multipliers	**Value as Export for Foreign Exchange as Multipliers**
Type of agriculture		
Maize	3	1
Rice	4	1
Other grains	2	1
Fruits/vegetables	2	1
Sugar cane	1	2
Roots*	3	1
Nuts**	1	3
Type of fishery product		
Lobster	1	2
Prawns and shrimp	1	5

*Roots include sweet potatoes, potatoes, and cassava.
**Nuts include peanuts and cashews.

Module 2, Investigation 3: Briefing

Who will feed the world?

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Module 2, Investigation 3: Log

Who will feed the world?

1. Make a line graph of world population from 1800 to 2043, using the data in Table 1. What does this curve look like, and why?

2. Using Figure 2, compare and contrast the diet in your region with the other regions.

3. How do you explain these differences in diets?

4. Compare and contrast the dietary energy supply levels in your region with the other regions. Specifically, name the countries (and their levels) in your region that have the highest and the lowest dietary energy supplies, and compare and contrast these with other countries with very high and very low levels.

Module 2, Investigation 3: Log
Who will feed the world?

5. With your team, brainstorm a list of reasons that might account for the variations in dietary energy supply levels between regions and countries and within countries.

6. According to Figure 6, which African regions have “very poor vegetation”? Why do you think this is so?

7. According to Figure 6, which African regions have shown “improvement” in their vegetation growth?

8. Estimate the cropland use intensity (CUI) for 1973, 1992, and 1995. How does this information assist your group in understanding agricultural production in Mozambique?

Module 2, Investigation 3: Log
Who will feed the world?

9. Put your group investment recommendations for the $40 million in the table below, and explain why you are investing this way.

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	Production Increase Per $1 Million Investment (in million tonnes)	**Consumption Multiplier**	**Foreign Exchange Multiplier**	**Investment** (in U.S. dollars)	**Return on Investment** (in million tonnes)
Type of agriculture					
Maize	1.00	3	1		
Rice	0.75	4	1		
Other grains	1.00	2	1		
Fruits/vegetables	0.75	2	1		
Sugar cane	0.75	1	2		
Roots*	0.75	3	1		
Nuts**	0.90	1	3		
Type of fishery product					
Lobster	0.90	1	2		
Prawns and shrimp	0.45	1	5		
			Total	$40 Million	

*Roots include sweet potatoes, potatoes, and cassava. **Nuts include peanuts and cashews.