CB 15 How Much Land Can Support a Person?

All organisms use energy. But how much energy does an organism need to stay alive? Producers, called autotrophs, use energy from the sun to make food. Consumers, or heterotrophs, obtain their energy from the food they eat. Thus, energy moves from its source in the sun to the photosynthetic producers. They transform light energy into chemical energy (food), and eventually to the consumers. How much energy do you think a human requires? How much energy do you use?

Part 1 Materials (per student)

- local map: for urban or suburban areas, a city or local area street map; for rural areas, a county road map
- state road map; or maps from *www.maps.excite.com* or *www.maps.lycos.com*
- US map showing biomes and a view of the Earth from space
- sheet of tracing paper
- pencil
- projection acetate for the class discussion
- Casio fx2 Graphing Calculator
- access to Internet
- Food calorie counter

Procedure

1. On the food data collection worksheet, keep a record of all the food you consumed during a two-day period. Separate combination foods into different categories.
2. Using a table similar to the *You Are What You Eat* worksheet on page 5, transform this to caloric content.
3. Calculate a typical day's food intake. Record foods in the categories given on the data sheet in the Appendix. The food **C**alorie (capital 'C') as noted in the diet books and on food labels is a kilocalorie (1,000 **c**alories). Count everything, not just what you eat at meals--snacks and candy count, too. Quantity is important. Estimate the quantity of individual foods as ounces, cups, or pieces.
4. Using a Calorie counter reference, determine the total number of Calories that you ate during your 48-hour data collection period. Calculating the total Calories in some prepared foods can be a problem; read labels and make judgments. For example, the Calories in most commercial salad dressings can be divided about half and half between vegetable oil and sugar. Potato chips often contain more fat than carbohydrates. Nutrition guides that include Calorie estimates are available as books and computer programs. If a food that you eat is not listed in these guides, use the estimate for a similar food. Refer to the Food Calorie Information Guide on pages 6 and 7 to find out more about counting calories and reading the caloric content on food labels.
5. To determine your average daily intake, divide the total number of Calories consumed for the two days by 2. Multiply this amount by 365 to determine the total number of Calories you take in during a year.
6. Use a table such as the How Much Land? found on page 6 and your Calorie data to determine the square meters of land required to support you. Do this by determining

the number of Calories that fall into each food category and divide each of the values by the "yield." Add all the values in the square meters of land column to arrive at the total land required to support you. Add the values in each subgroup (C_3 plants, C_4 plants, and animal products) to compare plant and animal requirements.

7. Calculate a class average for the square meters of land required to support an individual. Are you surprised? How does this compare to your prediction? How much productive land on Earth would be required to support 5 billion people at your level of caloric intake? How much land is there?

Interpretations

1. Once you know how many Calories you consume during a year, find the average number of calories you consume each day.
2. How many square meters of land do you need to support your average daily caloric intake?
3. If you take in 1000 calories a day, how many square meters of land do you need to support yourself?
4. One acre is 4046 square meters. Convert the square meters you need to support your daily intake to acres.
5. If you can have two harvests per year on your land, how much land do you need to support you for one year?
6. Assume that your family members each consume the same number of calories as you. How many acres of land would be needed to support your family for a year?
7. Assume that each of your classmates consume the same number of calories as you. How much land is needed to support your class for a year?

Applications

1. Can you think of an area of land that is about that size needed to feed your family for a year that is located near your school or home? Describe it.
2. Describe an area in your community that would be large enough to support (a) you, (b) your family, and (c) your class.
3. Japan has a human population of about 110 million. Its people enjoy one of the highest standards of living in the world. The entire country has an area of 142,726 square miles. There are 640 acres in a square mile. How many acres are there in Japan per person?
4. Compare the number of acres per person in Japan to the number of acres you need to support your caloric intake. How do these estimates differ?
5. How do you suppose the Japanese survive with so little land?
6. Do you actually need the number of calories you consume? Explain.

Casio FX2.0 Calculator Procedures for CB 15

Average Daily Caloric Intake and Yearly Caloric Intake

- ☞ Use the data you collected for the 48-hour calorie intake period. Since 48 hours is two days, you will total all the calories you ate during the 48 hour period and divide that total by two. This can be done from the RUN-MAT menu. Use the left parenthesis [( ] then enter the caloric amounts putting a plus between them [+], then the right parenthesis [ )], then the divide [÷], then [2], and finally [EXE]. This is your average daily caloric intake.
- ☞ Use the answer you just calculated and multiply it by 365 to calculate your yearly caloric intake: (*Average daily caloric intake*) [÷] [3][6][5] [EXE].

Square Meters of Land

- ☞ Organize your caloric intake data into food categories like the ones shown on the "How Much Land?" worksheet. Total each category amount, and determine the average daily caloric intake for each food category. Then determine the yearly caloric intake for each category. (See above section for procedures for finding average daily caloric intake and yearly caloric intake.)
- ☞ Using the "How Much Land?" worksheet, find the yield values associated with each food category. Divide the yearly caloric intake by the yield associated with that category. For example suppose your annual consumption of wheat cereal is 4800 calories per year. Divide 4800 by 810 to get about 5.9 square meters of land. Thus it would take almost 6 square meters of land to grow the amount of cereal you eat each year.
- ☞ Once you have determined the number of square meters needed for each category, total the square meter amounts together for the total amount of land required to grow the food you eat each year.

A Change in Diet

- ☞ Suppose you change your diet and lower your caloric intake to 1000 calories a day. To approximate how this will change the number of square meters of land needed for this change in your diet, you will need to set up a proportion as follows:

$$\frac{\text{Original Yearly Caloric Intake}}{\text{Original Square Meters of Land Needed}} = \frac{(1000)(365)}{X}$$

- ☞ To solve the proportion, cross multiply as follows:
(Original Yearly Caloric Intake) X = (365000)(Original Square Meters of Land Needed). Then divide both side of the equation by Original Yearly Caloric Intake to solve for X. This would be the new amount of land needed to support your diet change.

Acreage

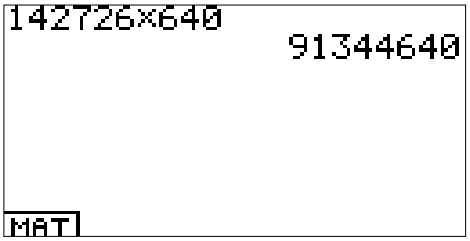
- ☞ To determine how many acres of land it takes to support your yearly intake you will use the conversion factor (1 Acre) / (4046 Square Meters). Take the original square meters of land needed and multiply it by the conversion factor as follows:

Original Square Meters of Land Needed . 1 Acres .
4046 Square Meters

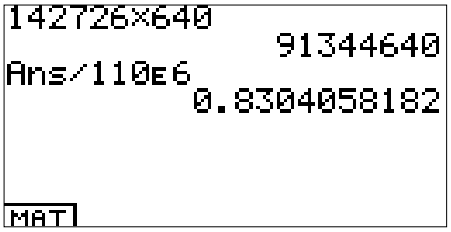
- The square meters divide out and the original number is actually divided by the 4046 to obtain the number of acres needed to grow the food you consume in a year.
- If you can have two harvests a year, you would simply divide the previous acreage by two.
- If each member in your family consumes the same number of calories per day that you do, then the number of acres needed to support your family each year is just the number of acres needed for you, multiplied by the number of members in your family. While caloric intake may vary between family members, this method would provide a decent estimate for acreage needs for your family. What are some other ways that you might find a more accurate estimate?
- If each member of your class consumes the same number of calories per day that you do, then the number of acres needed to support your class each year is just the number of acres needed for you, multiplied by the number of members of your class.

Japan

- To determine how many acres are in Japan, from the RUN-MAT menu enter the following: [1][4][2][7][2][6] [x] [6][4][0] [EXE]. See below.



- To find how many acres per person, divide The previous answer by 110 million people. To so this with the Casio FX2.0, you can recall the previous answer by pressing [SHIFT], then the negative key, [(-)], which activates the gold "Ans." Then press [÷] [1][1][0] [EXP] [6], which inputs 110 million using scientific notation. Finally press [EXE]. See below.



So there is about 0.83 acres per person in Japan.

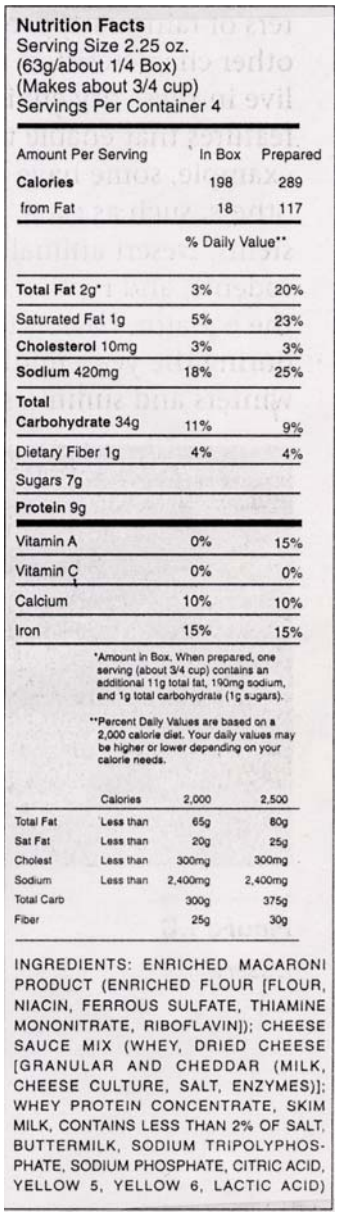
You Are What You Eat Worksheet

Food	Breakfast Lunch Dinner Between Meals	Total
Bread		
Wheat cereal		
Citrus fruits		
Orange Juice		
Coffee or Tea		
Peanut butter		
Rice/rice cereal		
Potatoes		
Vegetables		
Apples/fruits		
Vegetable oil		
Margarine		
Beef sugar		
Cane sugar		
Soft drinks		
Corn cereal		
Sweet corn		
Milk		
Cheese		
Eggs		
Chicken		
Pork		
Beef		
Fish		
Shrimp		
Total	**Your 24-hour gross energy intake in calories_____**	

How Much Land?

Food	**Annual Consumption Cal/year**	**Yield Cal/m^2/year**	**Square m of Land Needed to Support You** (Consumption÷Yield)
Bread		650	
Wheat cereal		810	
Oranges, grapefruit		1000	
Coffee		4	
Tea		40	
Peanut Butter		920	
Rice/rice cereal		1250	
Potatoes		1600	
Carrots		810	
Other vegetables		200	
Apples		1500	
Pears, peaches		900	
Vegetable oil		300	
Margarine		300	
Beet sugar		1990	
Cane sugar		3500	
Soft drinks		3500	
Corn cereal		1600	
Sweet corn		250	
Milk		420	
Cheese		40	
Eggs		200	
Chicken		190	
Pork		190	
Beef		130	
Fish		2	

Food Calorie Information for CB 15



Nutrition Facts
Serving Size 2.25 oz.
(63g/about 1/4 Box)
(Makes about 3/4 cup)
Servings Per Container 4

Amount Per Serving	In Box	Prepared
Calories	198	289
from Fat	18	117
	% Daily Value**	
Total Fat 2g*	3%	20%
Saturated Fat 1g	5%	23%
Cholesterol 10mg	3%	3%
Sodium 420mg	18%	25%
Total Carbohydrate 34g	11%	9%
Dietary Fiber 1g	4%	4%
Sugars 7g		
Protein 9g		
Vitamin A	0%	15%
Vitamin C	0%	0%
Calcium	10%	10%
Iron	15%	15%

*Amount in Box. When prepared, one serving (about 3/4 cup) contains an additional 11g total fat, 190mg sodium, and 1g total carbohydrate (1g sugars).

**Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholest	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carb		300g	375g
Fiber		25g	30g

INGREDIENTS: ENRICHED MACARONI PRODUCT (ENRICHED FLOUR [FLOUR, NIACIN, FERROUS SULFATE, THIAMINE MONONITRATE, RIBOFLAVIN]); CHEESE SAUCE MIX (WHEY, DRIED CHEESE [GRANULAR AND CHEDDAR (MILK, CHEESE CULTURE, SALT, ENZYMES)]; WHEY PROTEIN CONCENTRATE, SKIM MILK, CONTAINS LESS THAN 2% OF SALT, BUTTERMILK, SODIUM TRIPOLYPHOSPHATE, SODIUM PHOSPHATE, CITRIC ACID, YELLOW 5, YELLOW 6, LACTIC ACID)

The food Calorie (capital C) that is listed in popular Calorie-counting books and on food labels is the kilocalorie. You should get into the habit of assessing the Calorie content of the foods that you eat, preferably before you eat them. Notice especially the distribution of your food intake Calories among the various types of foods.

Foods, and the Calories in them, can be assigned to three basic categories: proteins, carbohydrates, and fats. Proteins and carbohydrates each provide 4 kilocalories of energy per gram. Fats provide 9 kilocalories of energy per gram. You can assess the Calorie content of your food by determining the relative proportions of carbohydrate, protein, and fat. Some foods with several components are difficult to categorize, but you can solve this problem by reading labels and making judgments. For example, the Calories in most kinds of commercial salad dressings can be divided about half and half between vegetable oil and sugar. Use a Calorie-counting book or chart to look up the foods you eat. The U.S.D.A. handbook entitled *The Nutritional Content of Foods* is an excellent source for Calorie and other nutritional information. Many fast-food restaurants provide booklets that contain nutritional analyses of their foods. If a food that you eat is not listed, look up a similar food. Count everything, not just what you eat at meals; snacks and candy count too! Quantity is important. You need to estimate the quantity of individual foods that you consume.

All processed food that is produced in the United States must list the information in Figure J.1. But what do you do with this information? How can you use this label to guide your food choices?

Current guidelines recommend restricting the fat in our diet to less than 30 percent of our total caloric intake. Some doctors recommend an even lower percentage: less than 20 percent of our food intake.

How would you determine the percentage of fat in macaroni and cheese? First, calculate the caloric percentages of carbohydrate, protein, and fat in one serving when prepared. One gram of either protein or carbohydrate provides 4 Calories. A 3/4 cup serving of prepared macaroni and cheese provides 9 grams of protein at 4 Calories/gram, for a total of 36 Calories of protein. That same serving provides 34 grams of carbohydrate at 4 Calories/gram, for a total of 136 Calories of carbohydrate. One gram of fat provides 9 calories. A serving of prepared macaroni and cheese provides 13 grams of fat at 9 Calories/gram, for a total of 11 7 Calories of fat.

Calculations:

9 grams protein x 4 Calories/gram = 36 Calories of protein
34 grams carbohydrate x 4 Calories/gram = 136 Calories of carbohydrate
13 grams fat x 9 Calories/gram = 117 Calories of fat

Therefore the distribution of Calories in a serving of macaroni and cheese is as follows:

CALORIES	
Carbohydrate	136
Protein	36
Fat	117
	289 calculated total calories per serving

Check the package label. Does this calculated value match the Calories per serving value on the label? It should. If your calculated value differs by a few calories from the label value, it's usually because the numbers have been rounded off.

Now calculate something that is not always included on the food label. Calculate the percentage of protein, carbohydrate, and fat in macaroni and cheese.

Calculations:

Percent calories from protein = (36 protein calories/289 total calories) x 100 = 12.5% calories from protein

Percent calories from carbohydrates = (136 carbohydrate calories/289 total calories) x 100 = 47.0% cal. from carbohydrates

Percent calories from fat = (117 fat calories/289 total calories) x 100 = 40.5% cal. from fat

Therefore the percent distribution of Calories in one serving is as follows:

	Percent of Total Calories
Carbohydrate	47.0%
Protein	12.5%
Fat	40.5%

Try making similar calculations for a few of your favorite foods. Record these calculations as data in your *Log,* and refer to them as you plan your daily diet.