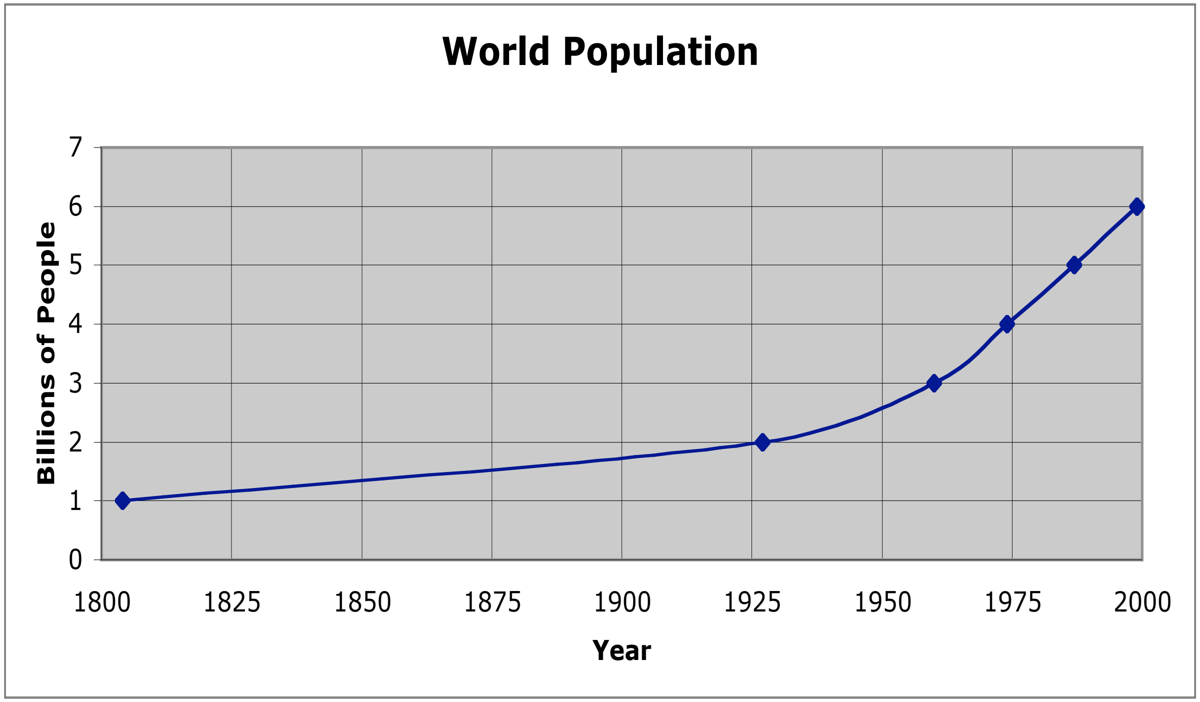


Growing world population and inadequate food supply have become concerns in recent years. In an effort to increase the food supply, scientists and farmers have proposed cultivating land areas that are currently covered with native grasses. A variety of factors must be studied to determine the soil best suited to growing crops as well as what type of crops to plant.

In this activity, you will examine some of the complex variables t interact to influence the selection of cropland and the appropriate crop

1) **(Plan Investigations: Specify measurement/variables to investigate) & (Interpret GLOBE Data: Explain data & relationships)** Identify two quantitative observations about a study site that will give information about the growing season at that site. Describe how each of these factors influence seed germination or affect the growth of food crops. For example: How long is the growing season? Even if the soil is full of nutrients and there is adequate precipitation, if the maximum and minimum air temperatures create a short growing season, the crops will not mature.

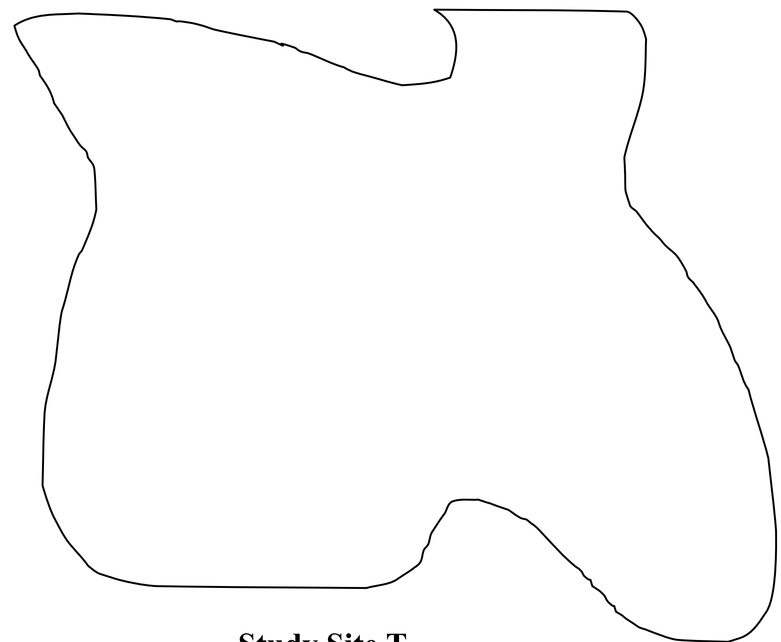
   Answers will vary though may include (but are not limited to):

   The amount of yearly precipitation is important to know because the growing plants will need a steady supply of water during their growth and development.

   The amount of precipitation during the previous winter / season is important to know because if it was below normal the soil may be too dry to support germination and early plant growth.

   The soil pH and nutrients are important factors to know because maximum plant growth will depend on the presence of all the essential nutrients.

2) **(Take GLOBE Measurements: Use quality assurance procedures)** A map of Study Site T is shown below. Identify how you would collect samples from 8 locations (A – H) within Study Site T. Explain why you created your sampling grid in this way.

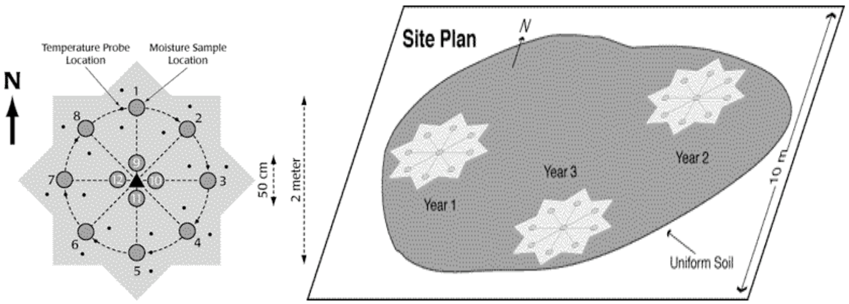


Study Site T

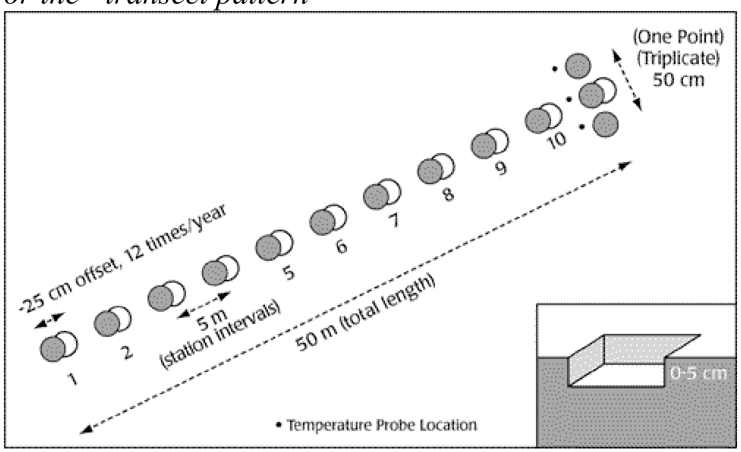
(Question 2 continued)

Answers will vary.

Some students may attempt to replicate the two patterns for collecting GLOBE soil data, i.e. "the star pattern"



or the "transect pattern"



Alternatively, the student may create a pattern that is a combination of these collection patterns OR create a new pattern. Whatever data collection pattern is used, the sites should be spread throughout Study Site T so that all areas are represented.

Table 1 shows soil measurements taken from Study Site T. Soil salinity is a measure of how much dissolved solids are present in a sample. It is measured using a conductivity meter which records how much electric current will pass through the sample. It is measured in units called mmho's (milli mho's).
Soil pH is a measure of the acidity/alkalinity of the soil. pH values range from 1 – 14. A pH of 7 is neutral. pH < 6.5 is acidic, while pH > 7.5 is alkaline.
The precipitation during the growing season has been measured for the past three years at Study Site T.

3) **(Interpret GLOBE Data: Create multiple formats to represent data)** Calculate the average precipitation during these three years. Add this value as another column in Table 1. Be sure to label the column and include the units used to measure precipitation.

Table 1: pH, salinity and annual precipitation for Study Site T

Soil Sample	Salinity	pH	Growing season precipitation for past three years			*ave. ppt.*
A	6mmho	5.0	10cm	10cm	13cm	*11cm*
B	10mmho	4.5	9cm	9cm	11cm	*9.7cm*
C	9mmho	5.5	19cm	20cm	21cm	*20cm*
D	9mmho	5.5	18cm	20cm	19cm	*19cm*
E	4mmho	5.5	24cm	24cm	24cm	*24cm*
F	5mmho	4.5	9cm	9cm	12cm	*10cm*
G	6mmho	5.5	21cm	24cm	25cm	*23.3cm*
H	9mmho	5.5	18cm	19cm	20cm	*19cm*

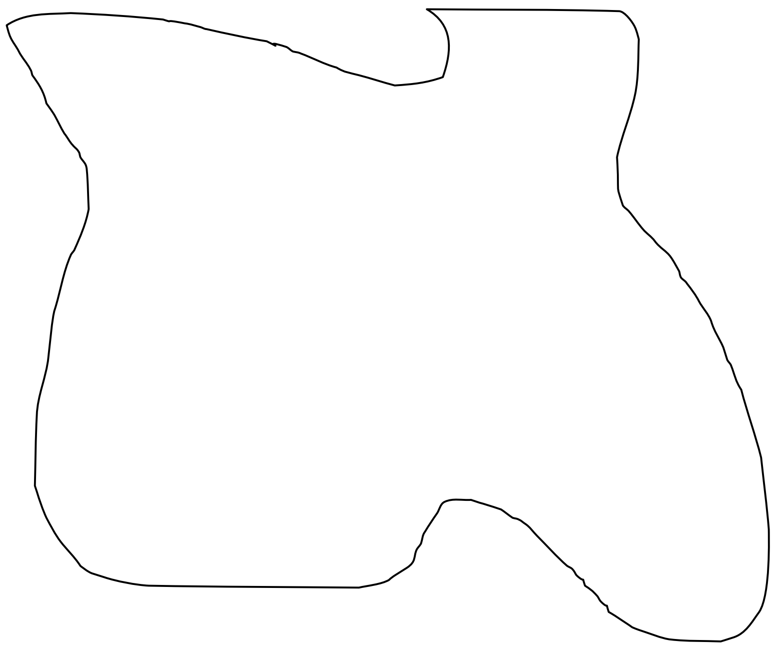
Table 2 shows the pH, salinity and minimum moisture needed for several food crops that grow in the general area of Study Site T.

Table 2: pH and salinity tolerance

Plants	pH*	salinity*	Minimum moisture needed to produce a crop yield
Crop W	6.0	12	16.8 cm
Crop X	5.5	9	17.3 cm
Crop Y	5.5	6	23.4 cm
Crop Z	4.5	9	8.9 cm

* these values indicate the lower limit of pH and the upper limit of salinity at which plants grow and produce without damage to crop yields

4) **(Interpret GLOBE Data: Explain data & relationships)** Use the information in Table 2 to identify where it might be possible to grow a Crop X in Study Site T. Describe the evidence that supports your conclusions.



Possible Growing Areas for Crop X within Study Site T

Answers will vary depending on how students set up the sampling pattern in Question2. However, the information in the table should be reflected on the map.

Site	*Crop Growth*	*Evidence*
A	*crop Z*	*pH too for other crops; other factors support growth of Z*
B	*none*	*pH too low for W, X, Y; salinity too high for Z*
C	***crop X, Z***	***pH too low for W; salinity too high for Y; moisture OK for X & Z***
D	***crop X, Z***	***pH too low for W; salinity too high for Y; moisture OK for X & Z***
E	***X, Y, Z***	***pH too low for W; other factors support growth of X, Y, Z***
F	*Z*	*pH too for W, X and Y; salinity & moisture OK for Z*
G	***X, Y, Z***	***pH too low for W; other factors support growth of X, Y, Z***
H	***crop X, Z***	***pH too low for W; salinity too high for Y; moisture OK for X & Z***

The amount of water that is used by a crop is equal to the amount of precipitation the area receives plus the amount of water in the soil. This amount of moisture is referred to as evapotranspiration or ET.

ET consists of two parts, evaporation and transpiration. Evaporation is the amount of water that evaporates from wet soil and plant surfaces after a rain. Transpiration is the amount of water that moves through the soil, into the roots, up the stem and moves out the leaves to the air. The water that is involved in transpiration is part of the photosynthesis process.

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5) **(Interpret GLOBE Data: Create multiple formats to represent data)** In the space below draw and label a diagram that shows the interactions between radiant energy, the water cycle of the atmosphere and the carbon-oxygen cycle of photosynthesis.

Drawings will vary, but should include the aspects indicated in the prompt.

6) **(Interpret GLOBE Data: Create multiple formats to represent data)** Write a description of how energy is used in these cycles. Include a description of the photosynthesis process in plants (chemical reactants, products, energy input and energy storage). Include a description of the energy release and energy uptake during the different stages of the water cycle.

Answers will vary. Students should include the following information:
re: photosynthesis
Plants use the sun's energy to combine carbon dioxide from the air and water from the soil to produce sugars that are used as building blocks for all other components needed by the plant.
re: water cycle
As water vapor cools in the upper levels of the atmosphere, it condenses and forms liquid water. When water droplet are too big/heavy to remain suspended in the air, they fall to the earth's surface in the form of precipitation (rain, snow, sleet, hail). Water collects on the earth's surface in rivers, ponds, lakes and oceans. As the water absorbs the radiant energy from the sun, some of the liquid water evaporates into the gaseous state. This water in the atmosphere begins the cycle over. (An additional component of transpiration may be mentioned. Water that percolates / soaks through the soil is taken up by plant roots. From here it may be used into photosynthesis OR it

may be released as gaseous water directly into the atmosphere during transpiration.)

Table 3 shows the average subsurface moisture levels available to plants during variable conditions of drought.

Table 3: Available subsurface moisture in Study Site T.

Description of Year	Available subsurface moisture
Year with average annual rainfall	10.2 cm
Year with below average annual rainfall (dry season = average – 30%)	9.0 cm
Year with above average annual rainfall (wet season = average + 30%)	11.0 cm

7) **(Interpret GLOBE Data: Create multiple formats to represent data)** Combine the data from Tables 1 and 3 to calculate the EvapoTranspiration levels for a wheat crop planted in your recommended areas. Include additional rows in the Table 4 as needed.

(ET = seasonal precipitation + soil moisture available to plant)

Table 4: EvapoTranspiration levels for proposed wheat-growing areas of Study Site T.

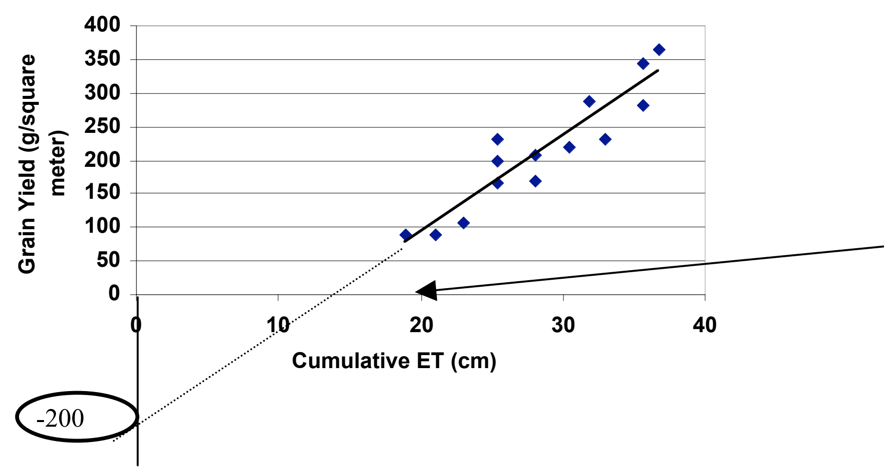
Recommended region for growing Crop X	ET during season of average rainfall	ET during predicted dry season (average – 30%)	ET during predicted wet season (average + 30%)
C	20cm + 10.2cm = **30.2cm**	14cm + 9.0cm = **23cm**	26cm + 11.0cm = **37cm**
D	19cm + 10.2cm = **29.2cm**	13.3cm + 9.0cm = **22.3cm**	24.7 + 11.0cm = **35.7cm**
E	24cm + 10.2cm = **35.2cm**	16.8cm + 9.0cm = **25.8cm**	31.2cm + 11.0cm = **42.2cm**
G	23.3cm + 10.2cm = **33.5cm**	16.3cm + 9.0cm = **25.3cm**	30.3cm + 11.0cm = **41.3cm**
H	19cm + 10.2cm = **29.2cm**	13.3cm + 9.0cm = **22.3cm**	24.7 + 11.0cm = **35.7cm**

8) **(Interpret GLOBE Data: Explain data & relationships)** Describe a procedure to calculate the average EvapoTranspiration for the entire region that you proposed as an area for growing Crop X. Explain why this is the best method to calculate the ET for the region.

Answers will vary to some extent based on the sampling pattern designed by the student in Question 2. This may impact the reasoning used to explain their "averaging" procedure. All responses should have some component of mathematical averaging and may have weighting factors as well.

Figure 1 shows a graph of the relationship between Cumulative EvapoTranspiration and grain yield for Crop X.

Figure 1: Production of Crop B as a Function of Water Use



Crop scientists use information like this to develop mathematical models. Using a model derived from the experiment shown above, they can predict a crop yield based on the amount of water available during the growing season.

The equation that describes the graph takes the classic form ($y = mx + b$) where:

y = crop yield (g/m^2)
m = slope of the line
x = cumulative EvapoTranspiration
b = where the line intercepts the y axis.

Crop scientists and farmers can use this data to estimate the yield for a crop when soil nutrients are not limiting and weed / insect pests are controlled.

9) **(Take GLOBE Measurement: Measurements are accurate and appropriate)** Calculate the slope of the line shown in Figure 1.

slope of the line is calculated: change in x ÷ change in y

(300 – 200) ÷ (35 –27) = 12.5

10) **(Take GLOBE Measurements: Measurements are accurate and appropriate)** Extrapolate the line in Figure 1 to determine the y-intercept.

y intercept = -200

11) **(Take GLOBE Measurements: Measurements are accurate and appropriate)** Write a mathematical model for predicting the yield of Crop X using cumulative ET as the variable.

Answers will vary to accommodate how students calculated the "average" precipitation for the area that will grow Crop X.

crop yield = 200(answer to Q8) + (- 200)

12) **(Take GLOBE Measurements: Measurements are accurate and appropriate)** Calculate the predicted yield of Crop X in Study Site T. Include calculations for:
    - an average moisture year
    - a predicted dry year
    - a predicted wet year

Use the space below to show all your calculations.

Answers will vary depending on how students calculated the average precipitation in Question 8. However, students will use the format identified in Question 11 and substitute the area's "dry season average precipitation" and the area's "wet season average precipitation".

13) **(Communicate: Create reports to explain or persuade)** Write a 2 - 3 page summary report to the farmers who work the land of Study Site T. Describe your recommendations for land use and the predicted range of Crop X. Explain how you made your decisions, why you made these recommendations, how you calculated the predicted yields, as well as any limitations or special considerations of your study and conclusions.