Activity: Comparisons of Future Biomass Production by Region

Grade Level: 9th grade Algebra 1

Alignment to Algebra 1 Standards:

- **A1.S.ID.B.4** Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
- **A1.S.ID.C.5** Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
- **A1.S.ID.C.6** Use technology to compute and interpret the correlation coefficient of a linear fit.

Learning Objectives:

- Create a scatterplot with labeled axes.
- Use graphing calculator to find linear regression equations for the given data set.
- Interpret slope of their models in the context of the problem.
- Analyze the correlation coefficient for regression equations.
- Analyze one data point and draw conclusions in context about its location relative to the line of best fit.

Materials: Graphing calculator, computer and projector

Time Required: 40 – 50 minutes (depending on students' comfort with using the necessary functions in the calculator) Note: This activity can easily have the time reduced by only doing problems 1-5.

Background Information: Bioenergy is energy derived from living matter on the surface of the earth. In the United States, we are at a historic high of renewable energy use. Bioenergy is the highest source of renewable energy.

In 2016 the US Department of Energy created the ***2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy.*** One of the focuses of the report is to create a projection analysis of biomass that will be available at different price points. They have made the report freely available on the web (https://www.bioenergykdf.net/ and click on "2016 Billion-Ton Report: Interactive Version". There is a wealth of data available as well as visualization tools.

Instructors' Notes: To see the data in a visualization web tool, go to the following address and change the year to 2030. All other variables are the defaults. https://www.bioenergykdf.net/billionton2016/1/7

Defaults when you open the tool are year 2040 (Note: this activity uses data from year 2030), 1% yield increase scenario, price offered of $60 per dry ton or less, and all feedstock grown in the state.

There are many areas to explore with this visualization tool. You can hold control and click to select a subset of states to view. You can particular feedstock, assume a greater price for feedstock or see how a higher percent yield increase will change the results. The raw data is also available to download.

Biofuel Application: In the United States it is projected that we increase our reliance on biofuel derived from renewable agricultural sources. Crops grown for bioenergy purposes are referred to as ***feedstock***. The data for select states, in the table to the right, represents projected amount planted and amount produced for the year 2030. Use the data in the table to answer the following questions.

Projected 2030 Agricultural Feedstock Data for Select Regions in the United States.

Region	State	Acres Planted (in millions)	Dry Tons Produced (in millions)
Pacific	WA	1.5	2.0
	OR	0.7	0.8
	CA	0.7	1.5
Mountain	MT	3.5	2.4
	ID	6.5	6.5
	WY	0.06	0.1
	UT	0.005	0.007
	CO	2.7	2.9
	NM	0.4	0.4
	AZ	0.02	0.04
Northern Plains	ND	8.4	9.9
	SD	7.0	13.5
	NE	9.3	23.3
	KS	11.0	37.1
Lake States	MN	8.4	19.4
	WI	3.2	7.8
	MI	2.4	4.5
Corn Belt	IA	9.9	26.9
	MO	4.4	31.6
	IL	8.1	21.2
	IN	3.5	7.9
	OH	3.5	8.1
Southeast	AL	1.0	5.7
	GA	0.9	4.2
	FL	0.8	6.0
	SC	0.6	2.9

1) Use your graphing calculator to find the equation for the line of best fit and the correlation coefficient for each of the six geographic regions in the table. Round all values to the nearest hundredths place.

Region	Equation of Line of Best Fit	Correlation Coefficient
Pacific		
Mountain		
Northern Plains		
Lake States		
Corn Belt		
Southeast		

2) Which region shows the strongest correlation between acres planted and dry tons produced? Explain.

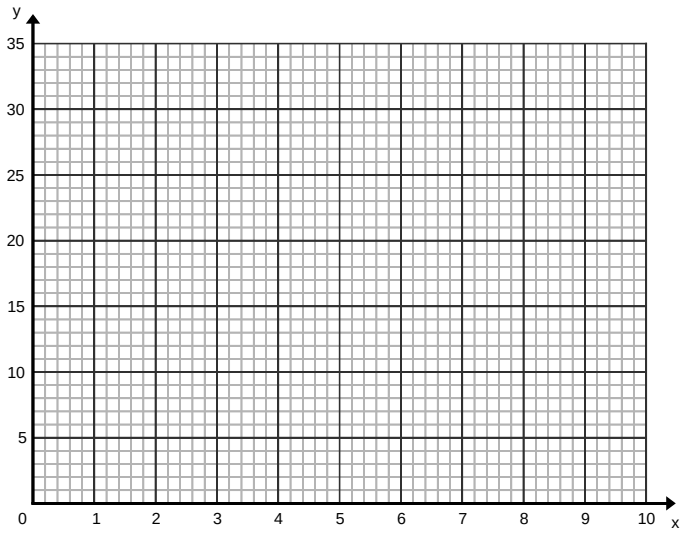
3) All of the correlation coefficient have a positive sign. Explain why this makes sense in the context of this scenario.

4) What is the meaning of the slope in the lines of best fit in the terms of acres planted and dry tons produced? Use units in the explanation.

5) Compare the slopes of the lines of best fit for the Mountain and Northern Plains regions. Why do these values make sense in terms of the geography of these regions?

6) Consider the Corn Belt region.

a. Create a scatter plot for the data for the Corn Belt region. Label your axes.



Region	State	Acres Planted (in millions)	Dry Tons Produced (in millions)
Corn Belt	IA	9.9	26.9
	MO	4.4	31.6
	IL	8.1	21.2
	IN	3.5	7.9
	OH	3.5	8.1

b. Graph your line of best fit that you found in #1 for this region.

c. Circle the point that represents Missouri. What do you notice about Missouri's location in relation to the line of best fit?

d. Based on the work you have done, what conclusion, in terms of acres planted and dry tons produced, can you make about feedstock production in Missouri as compared to the rest of the Corn Belt region?

e. What does the y-intercept mean in terms of acres of feedstock planted and dry tons of feedstock produced? Would the y-intercept make sense as a data point in this set of values?

f. ***Technology exploration:*** Go to https://www.bioenergykdf.net/billionton2016/1/7, change the year to 2030, and click on Missouri, so that it is the only state showing on the graph. Select different feedstock options from the choices on the left. Which one seems to account for the observation you made in part c? Do any other states grow this feedstock in large quantities?

Answer Key

Biofuel Application: In the United States it is projected that we increase our reliance on biofuel derived from renewable agricultural sources. Crops grown for bioenergy purposes are referred to as ***feedstock***. The data for select states, in the table to the right, represents projected amount planted and amount produced for the year 2030. Use the data in the table to answer the following questions.

Projected 2030 Agricultural Feedstock Data for Select Regions in the United States.

Region	State	Acres Planted (in millions)	Dry Tons Produced (in millions)
Pacific	WA	1.5	2.0
	OR	0.7	0.8
	CA	0.7	1.5
Mountain	MT	3.5	2.4
	ID	6.5	6.5
	WY	0.06	0.1
	UT	0.005	0.007
	CO	2.7	2.9
	NM	0.4	0.4
	AZ	0.02	0.04
Northern Plains	ND	8.4	9.9
	SD	7.0	13.5
	NE	9.3	23.3
	KS	11.0	37.1
Lake States	MN	8.4	19.4
	WI	3.2	7.8
	MI	2.4	4.5
Corn Belt	IA	9.9	26.9
	MO	4.4	31.6
	IL	8.1	21.2
	IN	3.5	7.9
	OH	3.5	8.1
Southeast	AL	1.0	5.7
	GA	0.9	4.2
	FL	0.8	6.0
	SC	0.6	2.9

1) Use your graphing calculator to find the equation for the line of best fit and the correlation coefficient for each of the six geographic regions in the table. Round all values to the nearest hundredths place.

Region	Equation of Line of Best Fit	Correlation Coefficient
Pacific	*y = 1.06x + 0.41*	*r = 0.81*
Mountain	*y = 0.95x – 0.03*	*r = 0.98*
Northern Plains	*y = 6.47x – 36 .80*	*r = 0.89*
Lake States	*y = 2.39x – 0.60*	*r = 0.996*
Corn Belt	*y = 2.03x + 7.19*	*r = 0.55*
Southeast	*y = 5.83x – 0.11*	*r = 0.69*

2) Which region shows the strongest correlation between acres planted and dry tons produced? Explain.

The Lake States region has the strongest correlation because its correlation coefficient is closest to 1.0.

3) All of the correlation coefficient have a positive sign. Explain why this makes sense in the context of this scenario.

A positive correlation coefficient indicates that as the domain values, acreage planted, increases, the range values, dry tons of feedstock produced increases. It makes sense that increasing the area planted would increase the feedstock produced.

4) What is the meaning of the slope in the lines of best fit in the terms of acres planted and dry tons produced? Use units in the explanation.

The slope is the number of dry tons produced per acre planted. Or, the number of additional dry tons of feedstock produced for every additional acre planted.

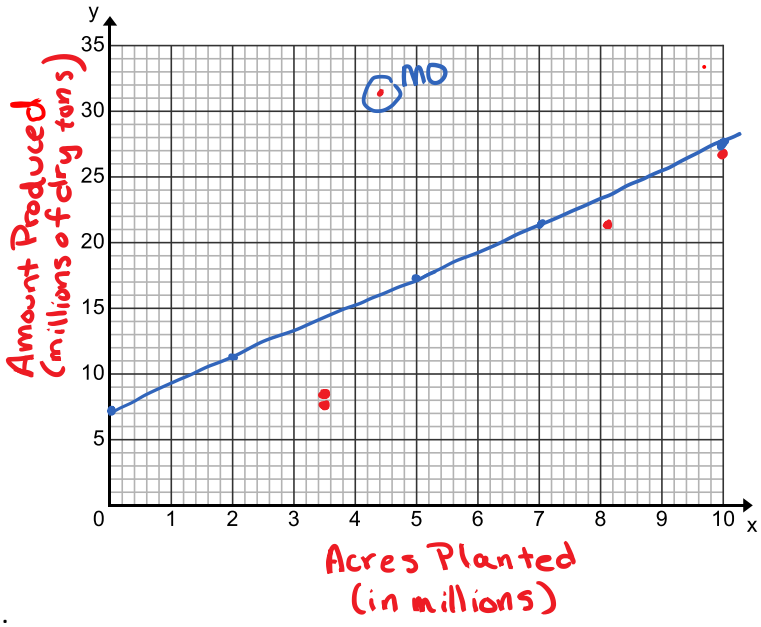
5) Compare the slopes of the lines of best fit for the Mountain and Northern Plains regions. Why do these values make sense in terms of the geography of these regions?

The slope of the Mountain region is 0.95, which is less than the slope of 6.47 for the Northern Plains region. The reason could include discussion of soil quality or types of crops suited to each region.

6) Consider the Corn Belt region.

a. Create a scatter plot for the data for the Corn Belt region. Label your axes.

Region	State	Acres Planted (in millions)	Dry Tons Produced (in millions)
Corn Belt	IA	9.9	26.9
	MO	4.4	31.6
	IL	8.1	21.2
	IN	3.5	7.9
	OH	3.5	8.1



b. Graph your line of best fit that you found in #1 for this region.

c. Circle the point that represents Missouri. What do you notice about Missouri's location in relation to the line of best fit?

Missouri's point is well above the line of best fit.

d. Based on the work you have done, what conclusion, in terms of acres planted and dry tons produced, can you make about feedstock production in Missouri as compared to the rest of the Corn Belt region?

In this projection, Missouri has a higher crop yield (ratio of dry tons produces to acres planted) than is typical for the region. Student may also hypothesize that Missouri better fits the behavior of a different region.

e. What does the y-intercept mean in terms of acres of feedstock planted and dry tons of feedstock produced? Would the y-intercept make sense as a data point in this set of values?

The y-intercept means that for 0 acres of feedstock planted, there would be 7.19 million dry tons of feedstock produced. This does not make sense because if no feedstock is planted, there will be none harvested.

f. ***Technology exploration:*** Go to https://www.bioenergykdf.net/billionton2016/1/7, change the year to 2030, and click on Missouri, so that it is the only state showing on the graph. Select different feedstock options from the choices on the left. Which one seems to account for the observation you made in part c? Does any other states grow this feedstock in large quantities?

Missouri projects a large production of miscanthus in comparison to most other states. Kansas does as well. While Kansas does not show up as an outlier, it does have the highest projected feedstock production for its region.