Agricultural Algebra: Average Daily Gain

High School

Algebra

Objectives

Students will apply algebraic concepts to solve real-world agricultural algebraic problems.

Vocabulary

average daily gain – the weight an animal gains on average for each day in between two weighing periods

market weight – the suggested ideal weight for harvesting animals, for swine the average market weight is 250 pounds, for cattle the average market weight is 1200 pounds.

slope – the change in rise over run in a line

Background

There is a desired weight many animals must weigh in order to be ideal for harvest for food. This term in the agricultural industry is called **market weight**. In order to reach the ideal market weight, producers feed the animals each day to help them gain weight. Sometimes when an animal becomes ill, they will stop eating for a period of time, and thus they do not gain as much weight. This delays the time needed for the animal to reach market weight. Producers can calculate how long it will take the animal to reach market weight using a simple algebraic equation. Once a producer has two weights on an animal, they can calculate the projected weight of the animal for a specific day, usually referred to as the animals harvest date. Finding the projected weight is as simple as projecting a line on a graph. The producer first calculates the **Average Daily Gain** (ADG), or the amount of weight the animal gained each day, which is the equivalent to the **slope** of the line. Here is the equation the producers use:

$$ADG = \frac{pounds\ gained\ since\ last\ weigh\ in}{number\ of\ days\ since\ last\ weigh\ in}$$

Agricultural Algebra: Average Daily Gain

High School

Teacher Resources

Activity 1 (Algebra): Average Daily Gain, 2-3 50 minute class periods

Materials

Math Activities

- Pen or Pencil
- Calculator
- Activity 1: Agricultural Algebra Worksheet

Agricultural Algebra: Average Daily Gain

High School

Standards

Oklahoma Academic Standards

Activity 1: Average Daily Gain

A1.A.1.3 Analyze and solve real-world and mathematical problems involving systems of linear equations with a maximum of two variables by graphing (may include graphing calculator or other appropriate technology), substitution, and elimination. Interpret the solutions in the original context.

Agricultural Algebra: Average Daily Gain

Name: _____

Date: _____ **Class/Hour/Teacher:** _____

Background

There is a desired weight many animals must weigh in order to be ideal for harvest for food. This term in the agricultural industry is called **market weight**. In order to reach the ideal market weight, producers feed the animals each day to help them gain weight. Sometimes when an animal becomes ill, they will stop eating for a period of time, and thus they do not gain as much weight. This delays the time needed for the animal to reach market weight. Producers can calculate how long it will take the animal to reach market weight using a simple algebraic equation. Once a producer has two weights on an animal, they can calculate the projected weight of the animal for a specific day, usually referred to as the animals harvest date. Finding the projected weight is as simple as projecting a line on a graph. The producer first calculates the **Average Daily Gain** (ADG), or the amount of weight the animal gained each day, which is the equivalent to the **slope** of the line. Here is the equation the producers use:

$$ADG = \frac{pounds\ gained\ since\ last\ weigh\ in}{number\ of\ days\ since\ last\ weigh\ in}$$

Recall, what is the equation for the slope of a line?

$$y = mx + b$$

In this example, ADG is equivalent to ____, the slope of the line.

Since we know that $slope = \frac{rise\ (change\ in\ y)}{run\ (change\ in\ x)}$ we know that our graph will be set up with ***pounds*** on the y axis and ***days*** on the x axis.

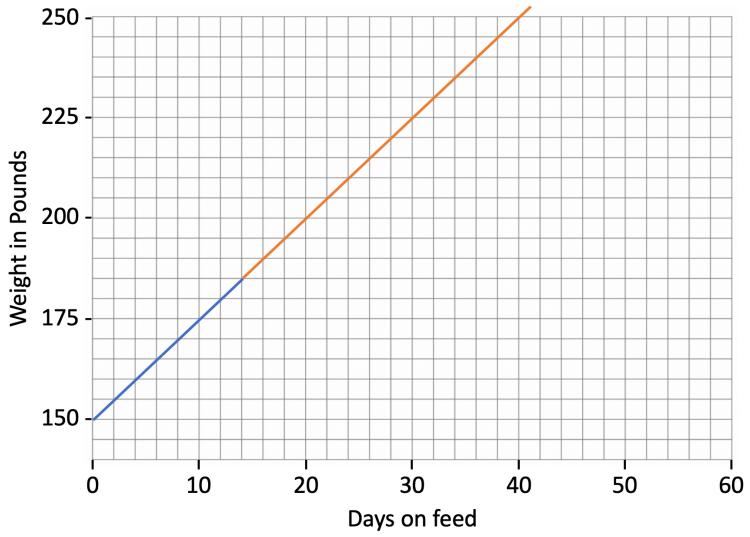
In addition, the first weight recorded, is recorded on *Day 0* and thus is set as the *y-intercept*.

EXAMPLE: Hog number 23-2 weighed 150 pounds on March 15th, so our y-intercept on Day 0 is 150 lbs. Hog number 23-2 weighed 185 pounds 14 days later. Calculate the ADG and graph this below.

$$ADG = \frac{pounds\ gained\ since\ last\ weigh\ in}{number\ of\ days\ since\ last\ weigh\ in} = \frac{185\ lbs - 150\ lbs}{14\ days} = \frac{35\ lbs}{14\ days} = 2.5\ lbs/day$$

Using the slope of the line, we can predict that Hog number 23-2 will reach market weight (250 lbs) on day 40. This can also be calculated using the equation for the line ($y = mx + b$).

$y = mx + b$ → $250 = 2.5(x) + 150$ → *solve for x . . . x = 40*



Problem Set

There are 8 pigs in a pen that the producer is hoping will reach market weight within 60 days. How much must each of the pigs gain per day in order to reach market weight (250 lbs.)? Remember the ADG is equal to the change in weight over the change in days. Once you find the slope (ADG) write the equation of the line using slope intercept form y=mx+b. We've done the equations for Pig 1 as an example.

Pig 1 – 98 lbs
$Y_1 = 98$
$Y_2 = 250$
$X_1 = \text{Day } 0$
$X_2 = \text{Day } 60$

$$m = \frac{Y_2 - Y_1}{X_2 - X_1} \qquad m = \frac{250 - 98}{60 - 0} \qquad m = \frac{152}{60} \qquad m = 2.53$$

$y = 2.53x + 98$

With a starting weight of 98 pounds, Pig 1 will need to gain 2.53 pounds per day in order to reach 250 pounds by day 60.

Pig 2 – 125 lbs
$Y_1 = 125$
$Y_2 = 250$
$X_1 = \text{Day } 0$
$X_2 = \text{Day } 60$

Pig 3 – 140 lbs
$Y_1 =$
$Y_2 =$
$X_1 = \text{Day } 0$
$X_2 = \text{Day } 60$

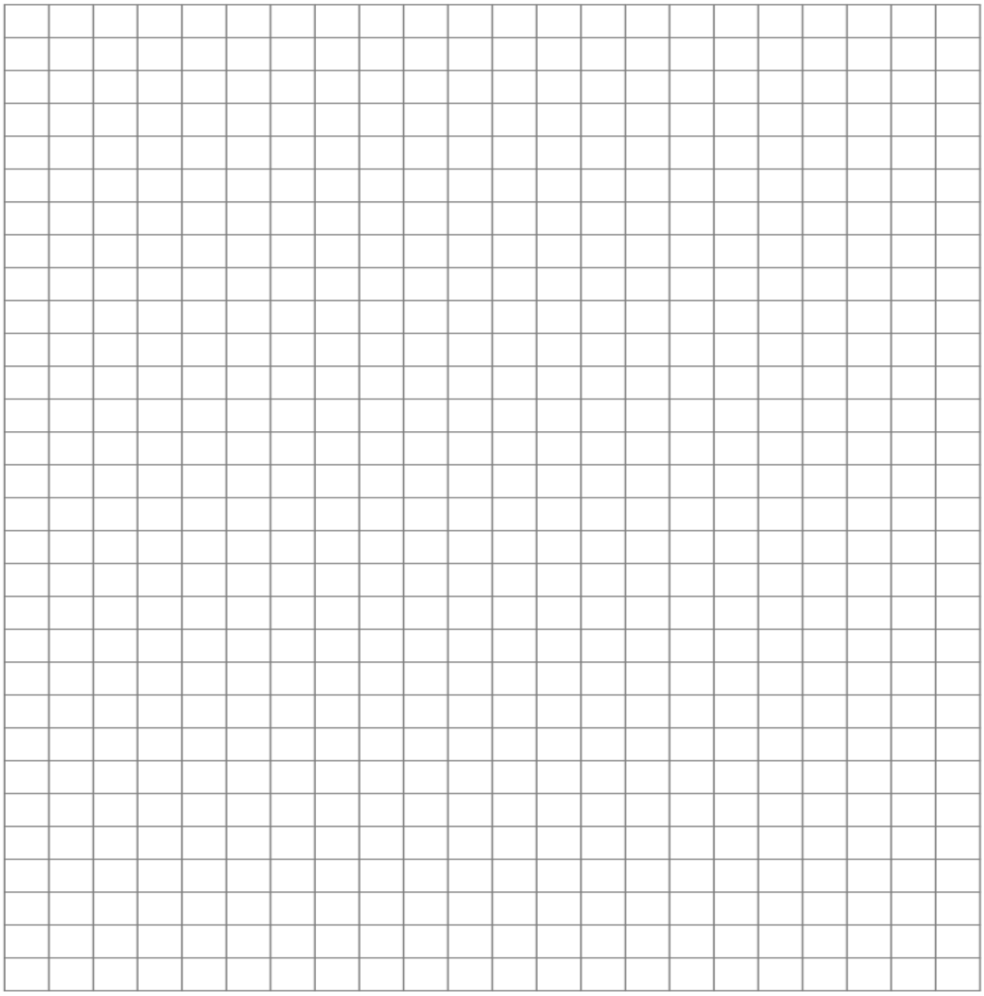
Pig 4 – 101 lbs
$Y_1 =$
$Y_2 =$
$X_1 =$
$X_2 =$

Pig 5 – 110 lbs
$Y_1 =$
$Y_2 =$
$X_1 =$
$X_2 =$

Pig 7 – 119 lbs $Y_1 =$ $Y_2 =$ $X_1 =$ $X_2 =$
Pig 8 – 105 lbs $Y_1 =$ $Y_2 =$ $X_1 =$ $X_2 =$
Pig 8 – 105 lbs $Y_1 =$ $Y_2 =$ $X_1 =$ $X_2 =$

Review Question 1:
If a pig gains on average 1.8 to 2.2 lbs. per day, are there any pigs that you think will not make it to 250 lbs within 60 days?

Using the graph below, chart each of the pigs' weight gain over the 60 days.



Review Question 2:
What do you notice about the graph when you compare it to your answer to Review Question 1? Explain your observations.

Using each of the pigs' beginning weight calculate how many days it will take each Pigs 1-4 to reach 250 lbs. at an ADG of 2.2 lbs. and Pigs 5-8 to reach 275 lbs. at 2.0 lbs. per day. Remember that their beginning weight is their weight on day 0, add days are on the x-axis. When $x = 0$ this is considered the y-intercept. Round all answers to two decimal places. We've done the equations for Pig 1 as an example.

Pig 1 – 98 lbs y = 250 m = 2.2 x = days to weight b = 98	y	=	m x + b	
	250	=	2.2x + 98	
	-98		-98	Subtract 98 from both sides
	152		2.2x	
	2.2		2.2	Divide both sides by 2.2
	69.09	=	x	
	With a starting weight of 98 lbs. and an average daily gain of 2.2 lbs, Pig 1 will reach 250 pounds in 69.09 days.			
Pig 2 – 125 lbs y = m = x = b =				
Pig 3 – 140 lbs y = m = x = b =				
Pig 4 – 101 lbs y = m = x = b =				
Pig 5 – 110 lbs y = m = x = b =				

Pig 6 – 91 lbs y = m = x = b =
Pig 7 – 119 lbs y = m = x = b =
Pig 8 – 105 lbs y = m = x = b =

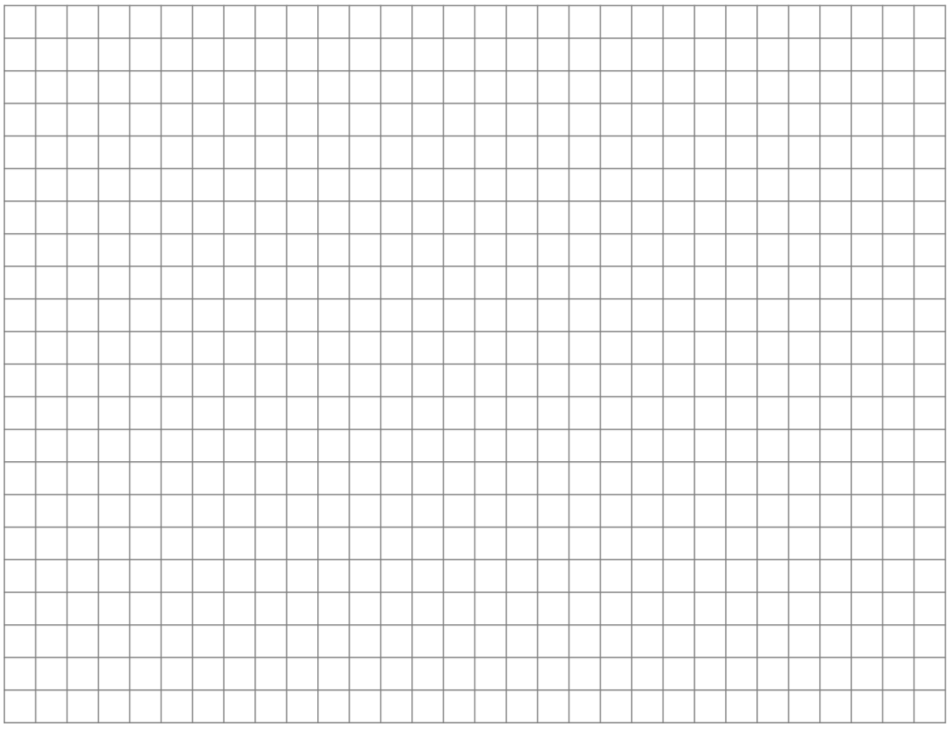
Graph this data on the following page.

What do you notice about the graphs?

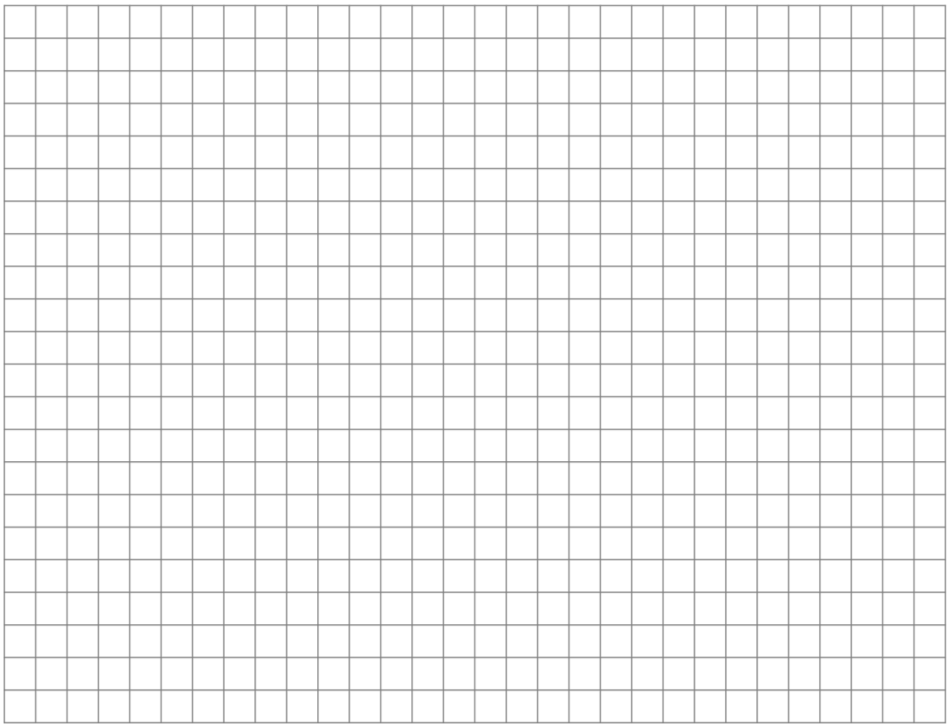
What does that tell you about a consistent ADG?

Graph the lines for Pigs 1-4 on Graph A and the lines for Pigs 5-8 on Graph B.

Graph B



Graph A



ANSWER KEY

Problem Set

There are 8 pigs in a pen that the producer is hoping will reach market weight within 60 days. How much must each of the pigs gain per day in order to reach market weight (250 lbs.)? Remember the ADG is equal to the change in weight over the change in days. Once you find the slope (ADG) write the equation of the line using slope intercept form y=mx+b

Pig 1 – 98 lbs Y_1 = 98 Y_2 = 250 X_1 = Day 0 X_2 = Day 60	$m = \frac{Y_2 - Y_1}{X_2 - X_1}$	$m = \frac{250 - 98}{60 - 0}$	$m = \frac{152}{60}$	$m = 2.53$ y = 2.53x + 98
With a starting weight of 98 pounds, Pig 1 will need to gain 2.53 pounds per day in order to reach 250 pounds by day 60.				
Pig 2 – 125 lbs Y_1 = 125 Y_2 = 250 X_1 = Day 0 X_2 = Day 60	$m = \frac{Y_2 - Y_1}{X_2 - X_1}$	$m = \frac{250 - 125}{60 - 0}$	$m = \frac{125}{60}$	$m = 2.08$ y = 2.08x + 125
With a starting weight of 125 pounds, Pig 2 will need to gain 2.533 pounds per day in order to reach 250 pounds by day 60.				
Pig 3 – 140 lbs Y_1 = 140 Y_2 = 250 X_1 = Day 0 X_2 = Day 60	$m = \frac{Y_2 - Y_1}{X_2 - X_1}$	$m = \frac{250 - 140}{60 - 0}$	$m = \frac{110}{60}$	$m = 1.83$ y = 1.83x + 140
With a starting weight of 140 pounds, Pig 3 will need to gain 1.83 pounds per day in order to reach 250 pounds by day 60.				
Pig 4 – 101 lbs Y_1 = 101 Y_2 = 250 X_1 = Day 0 X_2 = Day 60	$m = \frac{Y_2 - Y_1}{X_2 - X_1}$	$m = \frac{250 - 101}{60 - 0}$	$m = \frac{149}{60}$	$m = 2.48$ y = 2.48x + 101
With a starting weight of 101 pounds, Pig 4 will need to gain 2.48 pounds per day in order to reach 250 pounds by day 60				
Pig 5 – 110 lbs Y_1 = 110 Y_2 = 250 X_1 = Day 0 X_2 = Day 60	$m = \frac{Y_2 - Y_1}{X_2 - X_1}$	$m = \frac{250 - 110}{60 - 0}$	$m = \frac{140}{60}$	$m = 2.33$ y = 2.33x + 110
With a starting weight of 110 pounds, Pig 5 will need to gain 2.533 pounds per day in order to reach 250 pounds by day 60.				
Pig 6 – 91 lbs Y_1 = 91 Y_2 = 250 X_1 = Day 0 X_2 = Day 60	$m = \frac{Y_2 - Y_1}{X_2 - X_1}$	$m = \frac{250 - 91}{60 - 0}$	$m = \frac{159}{60}$	$m = 2.65$ y = 2.65x + 91
With a starting weight of 91 pounds, Pig 6 will need to gain 2.533 pounds per day in order to reach 250 pounds by day 60.				

Pig 7 – 119 lbs
$Y_1 = 91$
$Y_2 = 250$
$X_1 = \text{Day } 0$
$X_2 = \text{Day } 60$

$m = \frac{Y_2 - Y_1}{X_2 - X_1}$ $m = \frac{250 - 119}{60 - 0}$ $m = \frac{131}{60}$ $m = 2.18$

$y = 2.18x + 119$

With a starting weight of 119 pounds, Pig 7 will need to gain 2.18 pounds per day in order to reach 250 pounds by day 60.

Pig 8 – 105 lbs
$Y_1 = 91$
$Y_2 = 250$
$X_1 = \text{Day } 0$
$X_2 = \text{Day } 60$

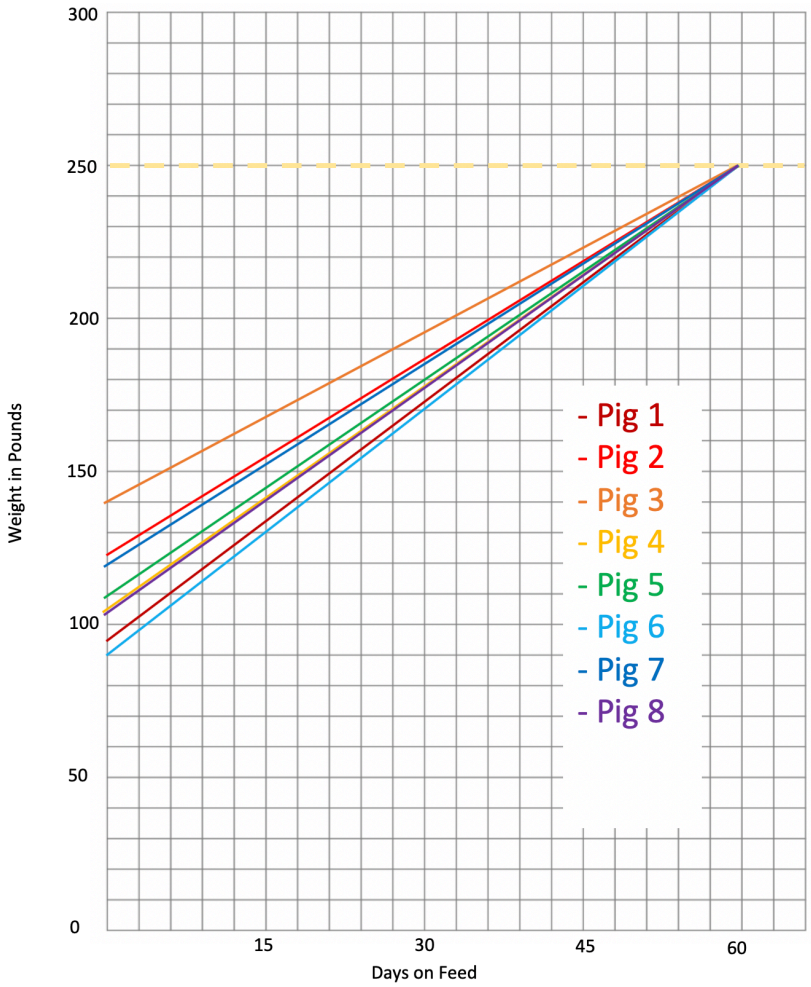
$m = \frac{Y_2 - Y_1}{X_2 - X_1}$ $m = \frac{250 - 105}{60 - 0}$ $m = \frac{145}{60}$ $m = 2.41$

$y = 2.41x + 105$

With a starting weight of 105 pounds, Pig 8 will need to gain 2.41 pounds per day in order to reach 250 pounds by day 60.

Review Question 1:
If a pig gains on average 1.8 to 2.2 lbs. per day, are there any pigs that you think will not make it to 250 lbs within 60 days?
Yes. There are 5 pigs that need to gain more than the average per day. Pig 1, Pig 4, Pig 5, Pig 6 and Pig 8 will not make weight if they only gain the average amount of weight each day.

Review Question 2:
What do you notice about the graph when you compare it to your answer to Review Question 1? Explain your observations.
The five pigs that are not going to make weight are the five lines with a steeper slope, and also start out with the lower initial weight. This makes sense because they have the more weight to gain (more rise) over the same amount of time, and that means they need to gain more weight per day.


300
250
200
150
100
50
0
Weight in Pounds
15
30
45
60
Days on Feed
- Pig 1
- Pig 2
- Pig 3
- Pig 4
- Pig 5
- Pig 6
- Pig 7
- Pig 8

Using each of the pigs' beginning weight calculate how many days it will take each Pigs 1-4 to reach 250 lbs. at an ADG of 2.2 lbs. and Pigs 5-8 to reach 275 lbs. at 2.0 lbs. per day. Remember that their beginning weight is their weight on day 0, add days are on the x-axis. When $x = 0$ this is considered the y-intercept. Round all answers to two decimal places. We've done the equations for Pig 1 as an example.

Pig 1 – 98 lbs y = 250 m = 2.2 x = days to weight b = 98	y 250 -98 152 2.2 69.09	= = =	m x + b 2.2x + 98 -98 Subtract 98 from both sides 2.2x 2.2 Divide both sides by 2.2 x With a starting weight of 98 lbs. and an average daily gain of 2.2 lbs, Pig 1 will reach 250 pounds in 69.09 days.
Pig 2 – 125 lbs y = 250 m = 2.2 x = days to weight b = 125	250 -125 125 2.2 56.82	= =	2.2x + 125 -125 Subtract 125 from both sides 2.2x 2.2 Divide both sides by 2.2 x With a starting weight of 125 lbs. and an average daily gain of 2.2 lbs, Pig 2 will reach 250 pounds in 56.82 days.
Pig 3 – 140 lbs y = 250 m = 2.2 x = days to weight b = 140	250 -140 110 2.2 50.00	= =	2.2x + 140 -140 Subtract 140 from both sides 2.2x 2.2 Divide both sides by 2.2 x With a starting weight of 140 lbs. and an average daily gain of 2.2 lbs, Pig 3 will reach 250 pounds in 50 days.
Pig 4 – 101 lbs y = 250 m = 2.2 x = days to weight b = 101	250 -101 149 2.2 67.73	= =	2.2x + 101 -101 Subtract 101 from both sides 2.2x 2.2 Divide both sides by 2.2 x With a starting weight of 101 lbs. and an average daily gain of 2.2 lbs, Pig 4 will reach 250 pounds in 67.73 days.
Pig 5 – 110 lbs y = 275 m = 2.2 x = days to weight b = 110	275 -110 165 2.0 82.5	= =	2.0x + 110 -110 Subtract 110 from both sides 2.0x 2.0 Divide both sides by 2.2 x With a starting weight of 110 lbs. and an average daily gain of 2.0 lbs, Pig 5 will reach 275 pounds in 82.5 days.

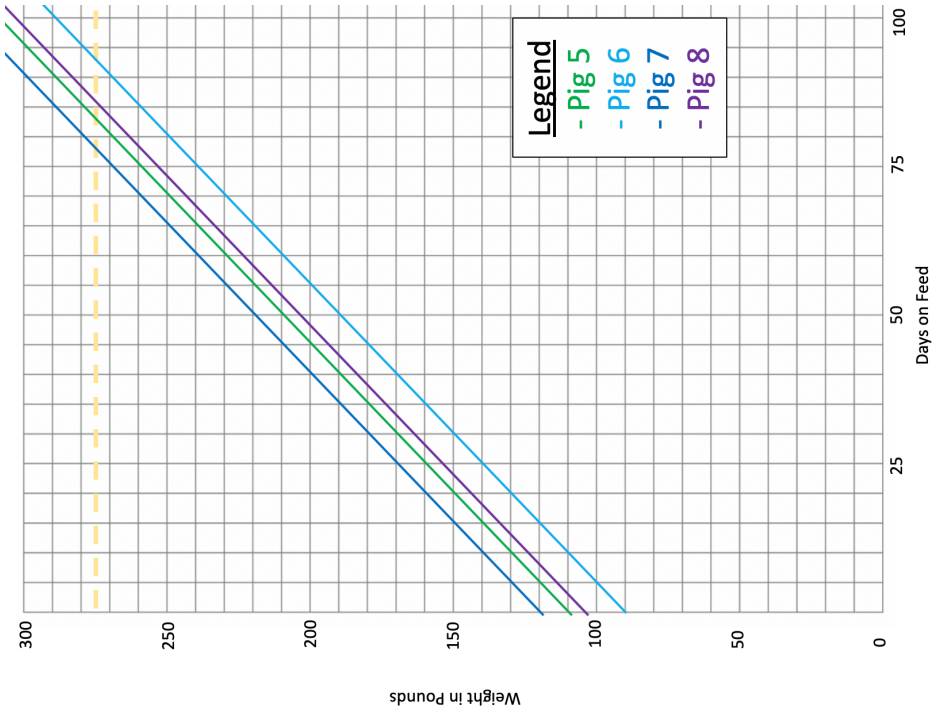
Pig 6 – 91 lbs y = 275 m = 2.2 x = days to weight b = 91	275 -91 184 2.0 92	 = 	2.0x + 91 -91 Subtract 91 from both sides 2.0x 2.0 Divide both sides by 2.2 x With a starting weight of 91 lbs. and an average daily gain of 2.0 lbs, Pig 6 will reach 275 pounds in 92 days.
Pig 7 – 119 lbs y = 275 m = 2.2 x = days to weight b = 119	275 -119 184 2.0 78	= =	2.0x + 119 -119 Subtract 119 from both sides 2.0x 2.0 Divide both sides by 2.2 x With a starting weight of 119 lbs. and an average daily gain of 2.0 lbs, Pig 7 will reach 275 pounds in 78 days.
Pig 8 – 105 lbs y = 275 m = 2.2 x = days to weight b = 105	275 -105 184 2.0 85	= =	2.0x + 105 -105 Subtract 105 from both sides 2.0x 2.0 Divide both sides by 2.2 x With a starting weight of 105 lbs. and an average daily gain of 2.0 lbs, Pig 8 will reach 275 pounds in 85 days.

What do you notice about the graphs?
The graphs each have four lines with similar slope and the lines are parallel to one another.

What does that tell you about a consistent ADG?
This shows that a consistent ADG can help to predict how many days it will take to reach a specific weight, and also shows that with consistent ADG, pigs that start at different weights will reach the target weight at different times. Furthermore, a higher ADG will make the pigs gain more weight per day, hence a steeper slope.

Graph the lines for Pigs 1-4 on Graph A and the lines for Pigs 5-8 on Graph B.

Graph B



Graph A