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Teaching Natural and Artificial Selection in Production Agriculture

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Teaching Natural and Artificial Selection in Production Agriculture

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(Faculty Mentors: Matthew L. Miller, [Madhav P Nepal](#), Larry B. Browning and Peter T. White); South Dakota State University, Brookings South Dakota)

Abstract: In this lesson, students will learn how natural selection and artificial selection impact both production agriculture and biological sciences. A natural selection is a mechanism that favors heritable traits that increase species survival and reproduction. Artificial selection is a selective breeding, where humans select for desirable traits in agricultural products.

Lesson Description:

Grade Level: Grade 9-12
Estimated Time for Completing Activity: Two 45-minute class periods, or One 90-minute block
Learning Outcomes: <ul style="list-style-type: none">• Students will be able to define natural selection (written/verbally) and give an example of natural selection in both Animal Science or Biology, with minimal (20%) error.
South Dakota Career and Technical Education (CTE) Standards: <ul style="list-style-type: none">• <i>INDICATOR #AN 5:</i> Study the reproductive system of animals.• <i>SUB-INDICATOR 5.2 (Webb Level: 1 Recall):</i> Discuss reproductive cycles and breeding techniques.
South Dakota State Science Standards:

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- *HS-LS2-8: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. (SEP: 7; DCI: LS2.D; CCC: Cause/Effect).*

<https://doe.sd.gov/contentstandards/documents/sdSciStnd.pdf>

Oceti Sakowin Essential Understandings and Standards:

<https://indianeducation.sd.gov/documents/OcetiSakowinEUS.pdf>

ESSENTIAL UNDERSTANDING 1: Essential Understanding 1: The original land base and natural resources of the Oceti Sakowin [oh-CHEH-tee shaw-KOH-we] were under communal stewardship prior to immigrant settlement. Oceti Sakowin have a distinct and unique interrelationship with the environment that is essential to South Dakota.

Standard 1.3 – Demonstrate understanding of the interrelationships of Oceti Sakowin people, places and environments within in all tribal lands in South Dakota. *Standard:* Students are able to identify and explain how a tribal government manages the ecosystem and its natural gifts.

Prerequisites:

A general understanding of both animal agriculture and biological heredity terminology.

Materials:

- Copies of Natural Selection vs Artificial Selection Venn Diagram Discussion sheet, one for each student.
- Copies of Natural Selection Guided Noted Sheets, one for each student.
- Copies of Artificial Selection Guide Note Sheets, one for each student.
- Copies of Pork Checkoff Board's article on Antibiotic Resistance and Antibiotic Residue (<https://www.pork.org/public-health/antibiotic-residues-vs-resistance/>), one for each student.
- Copies of Artificial Selection EPD Worksheet., one for each student.
- Projector
- Computer with Biology-Natural Selection PowerPoint
- Writing Utensils

Vocabulary:

- Angus
- Antibiotic resistance

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- Artificial selection
- Back Fat (BF)
- Calving Ease Maternal (CEM)
- Cause of organic evolution
- Charles Darwin
- Estimated Progeny Difference (EPD)
- Marbling (IMF)
- Maternal Milk (MM)
- Maternal Trait
- Mature Cow Weight (MCM)
- Natural selection
- Production Trait
- Ribeye Area (REA)
- Scrotal Circumferences (SC)
- Terminal Trait
- Weaning Weight (WW)
- Yearling Weight (YW)

Lesson Links and References:

- https://en.wikipedia.org/wiki/Natural_selection
- https://en.wikipedia.org/wiki/Selective_breeding
- Khan Academy. (n.d.). Darwin, evolution, & natural selection. Retrieved October 13, 2019, from Khan Academy
<https://www.khanacademy.org/science/biology/her/evolution-and-natural-selection/a/darwin-evolution-natural-selection>
- Khan Academy. (n.d.). Evolution: Natural selection and human selection article. Retrieved October 13, 2019, from Khan Academy
<https://www.khanacademy.org/science/ap-biology/natural-selection/artificial-selection/a/evolution-natural-selection-and-human-selection>
- Koeman, J. a. (2019, June 16). Antibiotic Residues vs. Resistance: Retrieved from Pork Checkoff: <https://www.pork.org/public-health/antibiotic-residues-vs-resistance/>
- Schmidt, B. (2019, March 25). Genetic selection. Brookings, South Dakota . Retrieved December 31, 2019
- Select Sires. (n.d.). 7AN475 CONNEALY CONVICTION 6828. Retrieved October 2019, 2019, from Select Sires : <https://selectsiresbeef.com/bull/angus/connealy-conviction-6828/>
- Select Sires. (n.d.). 7AN516 RES DARK FIRE E612. Retrieved October 13, 2019, from Select Sires: <https://selectsiresbeef.com/bull/angus/res-dark-fire-e612/>

Background:

A natural selection is the process that favors heritable (inherited) traits that increase the survival chances of an organism, allowing the organism to reproduce more.

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Primary factors that limit the natural selection process is the availability of food, habitat, and mates. Artificial selection is a selective breeding, where humans select for desirable traits in agricultural products. The mechanism of natural selection was first proposed by Charles Darwin and it is the main cause of organic evolution.

Procedure:

Day 1:

- **Introduction: Natural Selection**

- Natural VS Artificial Selection Venn Diagram
 - Think-Pair-Share Instructions:
 1. Display discussion question(s) on the board and pass out Venn Diagram note sheet.
 2. Instruct students to silently think about the posed question for 1 minute. Have students write their initial thoughts down on the top portion of the Venn Diagram, during that time.
 3. After a minute, have students pair up and exchange their thoughts, for a minute.
 4. After the minute, bring the discussion to the entire class for a discussion.

Discussion Topic 1: What is Natural Selection and how does it compare with Artificial Selection? (I.e., their definition, historical/present applications, personal experiences, etc.)?

- **Instruction:** Review the Natural VS Artificial Selection PowerPoint (slides 1-6).

- Activity 1: Definitions
 - Natural Selection – A process that favors heritable (inherited) traits that increase the survival chances of an organism, allowing the organism to reproduce more. (NOTE: Factors that limit the natural selection process is the availability of **food, habitat, and mates**.)
 - Example of Natural Selection
 - Antibiotic Resistance - Bacteria develop the capacity to inactivate or exclude antibiotics or develop a mechanism to block the inhibitory or killing effects of antibiotics.
 - Humans-When you are ill, the pathogenic bacteria inside of you are for the most part the same, but there are some bacteria that develop unique genetic characteristics. Bacteria that have developed those unique genetic characteristics are resistant to antibiotics, which allows these unique bacteria thrive in their environment, where they replicate, and continue to make you sick.

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- Livestock- Review the Pork Checkoff Board’s article on Antibiotic Resistance and Antibiotic Residue (<https://www.pork.org/public-health/antibiotic-residues-vs-resistance/>)
- Compare and contrast Antibiotic Resistance and Antibiotic Residue. Draw a “T” Chart on the Whiteboard. Ask students for their observations on both Antibiotic Resistance and Antibiotic Residue from the article.
- Withdraw Period - The time between the last dose given to the animal and the time when the residue level in tissues (muscle, liver, kidney, and fat) or products is lower than or equal to the MRL (Maximum Residue Level).

- **Assessment Day-1:**

1. Diagnostic: Top half of the Natural VS Artificial Selection Venn Diagram (see page 56)
2. Formative: Following discussion.
3. Summative: Bottom half of the Natural VS Artificial Selection Venn Diagram.

Day 2:

- **Review**

- Natural Selection – A process that favors heritable (inherited) traits that increase the survival chances of an organism, allowing the organism to reproduce more.

- Antibiotic Resistance -

- **Introduction: Artificial Selection**

- Natural VS Artificial Selection Venn Diagram
 - Think-Pair-Share Instructions:
 1. Display discussion question(s) on the board and pass out Venn Diagram note sheet.
 2. Instruct students to silently think about the posed question for 1 minute. Have students write their initial thoughts down on the top portion of the Venn Diagram, during that time.
 3. After a minute, have students pair up and exchange their thoughts, for a minute.
 4. After the minute, bring the discussion to the entire class for a discussion.

Discussion Topic 2: What is Artificial Selection and how does it compare with Natural Selection? (I.e., their definition, historical/present applications, personal experiences, etc.)?

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- **Review**
 - Definitions:
 - Natural Selection – A process that favors heritable (inherited) traits that increase the survival chances of an organism, allowing the organism to reproduce more.
 - Example: Antibiotic Resistance
- **Instruction:** Review the Natural VS Artificial Selection PowerPoint (slides 7-19).
 - **Definitions:**
 - Artificial Selection – “Selective Breeding” Is where humans select for desirable traits in agricultural products, or animals.
 - **Ask:** What traits do you believe producers are looking for when raising beef cattle. How do you think these traits are measured?
 - Estimated Progeny Difference (EPD) – A prediction of how future progeny are expected to perform relative to other animals in the breed.
 - Terminal Trait – A prediction of how future progeny are expected to perform relative to other animals in the breed.
 - Ribeye Area (REA) – A predictor of the difference in ribeye area of a sire’s progeny compared to progeny of other sires.
 - Marbling (IMF) – A predictor of the difference in a sire’s progeny for percent marbling score or percent intramuscular fat in the ribeye muscle compared to other sires.
 - Back Fat (BF) – The adjusted twelfth rib fat thickness of a sire’s progeny, expressed in inches.
 - Production Trait – Traits passed down from the sire, related to the harvest and processing of the animal.
 - Weaning Weight (WW) – Expressed in pounds, a predictor of a sire’s ability to transmit weaning growth to his progeny compared to that of other sires.
 - Yearling Weight (YW) – Expressed in pounds, a predictor of a sire’s ability to transmit yearling growth to his progeny compared to that of other sires.
 - Scrotal Circumferences (SC) – Expressed in centimeters, a predictor of the difference in transmitting ability for scrotal size compared to that of other sires.
 - Maternal Trait – Traits related to the maternal abilities of the sire’s daughters.
 - Calving Ease Maternal (CEM) – Expressed as a difference in percentage of unassisted births with a higher value indicating greater calving ease in first-calf daughters.
 - Maternal Milk (MM) – Milking ability of an animal’s daughters. This difference in milking ability is expressed as additional pounds of calf weaned by a bull’s daughter.

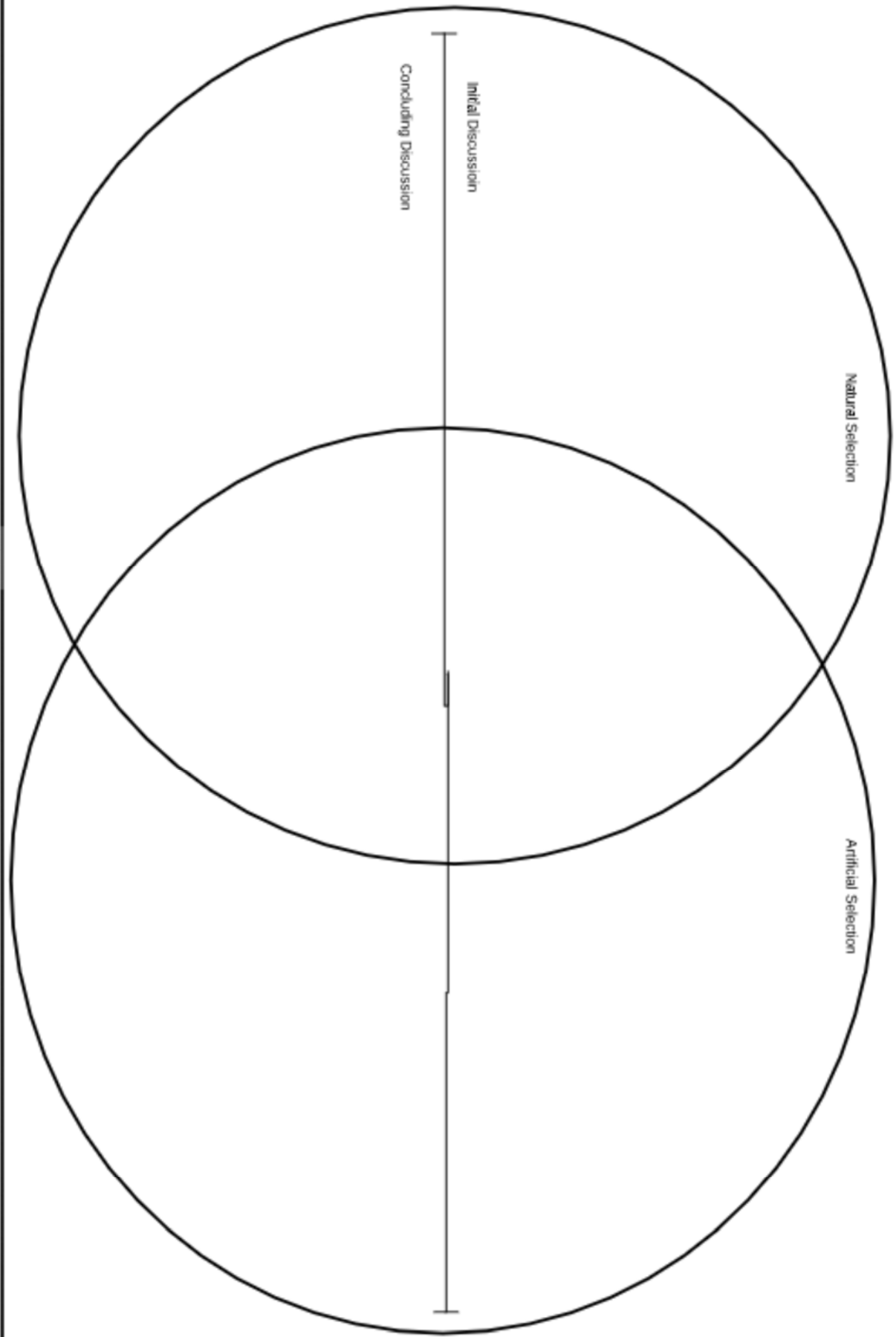
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<ul style="list-style-type: none">○ Mature Cow Weight (MCM) – A predictor of the difference in mature weight of daughters of a sire compared to the daughters of other sires.▪ Angus – A British breed, brought to the United States in 1873. Known for their advantageous marbling, calving ease, mothering abilities, and the for the Certified Angus Program. <ul style="list-style-type: none">● Practice: EPD Bull Selection Activity<ol style="list-style-type: none">1. Distribute worksheets to students2. Review how to read/compare or compare an EPD report.3. Select desired EPD trait (top row list of acronyms)4. In the row directly beneath the EPD trait value, this value represents the accuracy of the measurement of the EPD Value. This number is above the5. Below the accuracy value, this value represents the EPD Trait’s value ranking, as a percentage, compared among the entire breed.6. These values are compared to either one other bull, or several when producers are making decisions regarding artificial insemination.
<ul style="list-style-type: none">● Assessment Day-2:<ul style="list-style-type: none">○ Diagnostic Assessment – Venn Diagram Discussion Sheet (Top 1/2 of Diagram)○ Formative Assessment – Think-Pair-Share Discussion over Venn Diagram Note Sheet○ Summative Assessment – Venn Diagram Discussion Sheet (Bottom ½ of Diagram).
See page 56-60 for the worksheets. Supplementary File includes PowerPoint presentation.

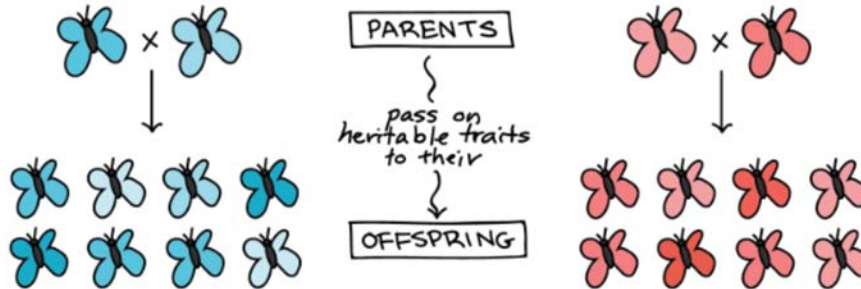
- **Acknowledgement:** The iLEARN project is supported by USDA-AFRI (Award # 2017-68010-25956)
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Natural VS Artificial
Selection Venn Diagram



Define Natural Selection _____

EX:



What three limited resources can affect offspring's chances of survival?

In the population, some individuals have inherited traits that help them survive and reproduce. These helpful traits will become more common in further generations. Populations with these helpful traits are said to of _____ to their environment.

What is an example of natural selection that affects both humans and livestock? (HINT: Look at the article attached to your note set). _____.

QUESTIONS FROM THE ARTICLE

What is the difference between antibiotic resistance and antibiotic residues?

Antibiotic Resistance

Antibiotic Residues

Define withdrawal period. _____

What are three methods producers can utilize to prevent antibiotic resistance?

1. _____
2. _____
3. _____

Define Artificial Selection _____

What traits do you believe producers are looking for when raising beef cattle?

How are these traits measured? _____

Producers measure desired traits by utilizing a system known as Estimated Progeny Differences (EPD).

Define Estimated Progeny Difference (EPD). _____

Instructions: Following along with the PowerPoint, write the correct term and abbreviation with the corresponding definition blank, below.

Mature Cow Weight (MCM)	Weaning Weight (WW)	Ribeye Area (REA)	Calving Ease Maternal (CEM)
Scrotal Circumference (SC)	Marbling—IMF	Maternal Milk— MM	Yearling Weight—YW
	Back Fat— BF		

Terminal Traits—A prediction of how future progeny are expected to perform relative to other animals in the breed.

_____ – A predictor of the difference in ribeye area of a sire’s progeny compared to progeny of other sires.

_____ – A predictor of the difference in a sire’s progeny for percent marbling score or percent intramuscular fat in the ribeye muscle compared to other sires.

_____ – adjusted twelfth rib fat thickness of a sire’s progeny, expressed in inches.

Production Traits—Traits passed down from the sire, related to the harvest and processing of the animal.

_____ – Expressed in pounds, a predictor of a sire’s ability to transmit weaning growth to his progeny compared to that of other sires.

_____ – Expressed in pounds, a predictor of a sire’s ability to transmit yearling growth to his progeny compared to that of other sires.

Scrotal Circumferences (SC) – Expressed in centimeters, a predictor of the difference in transmitting ability for scrotal size compared to that of other sires.

Maternal Traits—Traits related to the maternal abilities of the sire’s daughters.

_____ – Expressed as a difference in percentage of unassisted births with a higher value indicating greater calving ease in first-calf daughters.

_____ – Milking ability of an animal’s daughters. This difference in milking ability is expressed as additional pounds of calf weaned by a bull’s daughter.

_____ – A predictor of the difference in mature weight of daughters of a sire compared to the daughters

of other sires

How to read/compare an EPD Report(s).

Step 1:

Select desired EPD Trait.

	CEU	SW	WW	FW	BAWL	DM	TM	SC	DOC
EPD	31	47	38	48	122	124	122	12	18
Acc	0.88	0.88	0.88	0.78	0.87	0.87	0.88	0.88	0.75
% Rank	10	10	45	45	35	44	35	45	75

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How to read/compare an EPD Report(s).

Step 1:

Select desired EPD Trait.

	CEU	SW	WW	FW	BAWL	DM	TM	SC	DOC
EPD	31	47	38	48	122	124	122	12	18
Acc	0.88	0.88	0.88	0.78	0.87	0.87	0.88	0.88	0.75
% Rank	10	10	45	45	35	44	35	45	75

Step 2:

Read EPD trait value

	CEU	SW	WW	FW	BAWL	DM	TM	SC	DOC
EPD	31	47	38	48	122	124	122	12	18
Acc	0.88	0.88	0.88	0.78	0.87	0.87	0.88	0.88	0.75
% Rank	10	10	45	45	35	44	35	45	75

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How to read/compare an EPD Report(s).

Step 3:

EPD trait value accuracy.

	CEU	SW	WW	FW	BAWL	DM	TM	SC	DOC
EPD	31	47	38	48	122	124	122	12	18
Acc	0.88	0.88	0.88	0.78	0.87	0.87	0.88	0.88	0.75
% Rank	10	10	45	45	35	44	35	45	75

How to read/compare an EPD Report(s).

Step 3:

EPD trait value accuracy.

	CEU	SW	WW	FW	BAWL	DM	TM	SC	DOC
EPD	31	47	38	48	122	124	122	12	18
Acc	0.88	0.88	0.88	0.78	0.87	0.87	0.88	0.88	0.75
% Rank	10	10	45	45	35	44	35	45	75

Step 4:

EPD trait percentage among entire breed.

	CEU	SW	WW	FW	BAWL	DM	TM	SC	DOC
EPD	31	47	38	48	122	124	122	12	18
Acc	0.88	0.88	0.88	0.78	0.87	0.87	0.88	0.88	0.75
% Rank	10	10	45	45	35	44	35	45	75

Artificial Selection EPD Worksheet

Bull 1: RES DARK FIRE E612

Bull 2: CONNEALY CONVICTION 6828



EPD Trait	Calving Ease	Milk	Marbling	EPD Trait	Calving Ease	Milk	Marbling
EPD	14	35	1.01	EPD	0.0	19	0.87
Average	0.34	0.34	0.41	Average	0.37	0.32	0.36
Accuracy	4	0.41	10	Accuracy	90	85	35

Scenario 1: You are a angus cattle producers in Western South Dakota, you are concerned about a few of your first year heifers' ability to successfully calve unassisted. Which bull would you select to breed with your first year heifers and why?

Scenario 2: You are an angus cattle producer in Western South Dakota, you are interested in increasing your calves hanging carcass value. Which bull would you select to breed with your heifers and why?-
