2026

Junior Dairy Management Study Guide

Cattle Selection-Linear

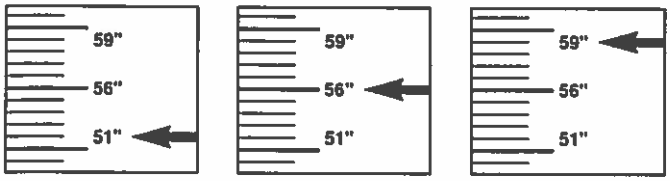
Linear Descriptive Traits



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STATURE - ST
Primary Trait



1-5 pts.
Extremely short

25 pts.
Intermediate

45-50 pts.
Extremely tall

RUMP WIDTH - RW
Primary Trait



1 pt. = 2"
Extremely narrow

25 pts. = 4-1/2"
Intermediate width

50 pts. = 7"
Extremely open

STRENGTH - SR
Primary Trait



1-5 pts.
Extremely narrow and frail

25 pts.
Intermediate

45-50 pts.
Extremely strong & wide

REAR LEGS, SIDE VIEW - LS
Primary Trait



1-5 pts.
Posty and straight

25 pts.
Intermediate set in hock

45-50 pts.
Extremely sickled

BODY DEPTH - BD
Primary Trait

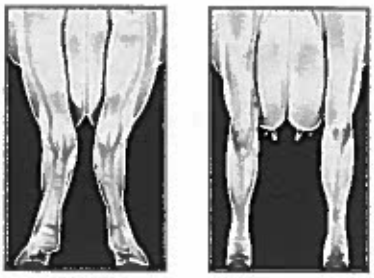


1-5 pts.
Extremely shallow body

25 pts.
Intermediate

45-50 pts.
Extremely deep body

REAR LEGS, REAR VIEW - RL
Primary Trait



1-5 pts.
Severe toe-out

45-50 pts.
No toe-out

DAIRY FORM - DF
Primary Trait



1-5 pts.
Extremely tight

25 pts.
Intermediate

45-50 pts.
Extremely open

FOOT ANGLE - FA
Primary Trait



1-5 pts.
Extreme low angle

25 pts.
Intermediate angle

45-50 pts.
Extremely steep angle

RUMP ANGLE - RA
Primary Trait

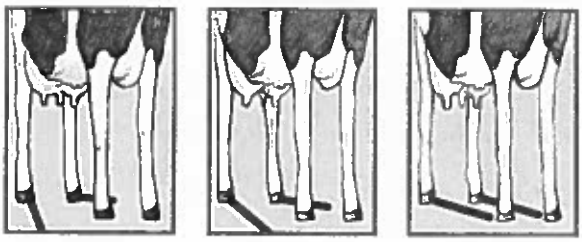


1-5 pts.
Pins clearly higher than hooks

25 pts.
Slight slope from hooks to pins

45-50 pts.
Extremely sloped from hooks to pins

LOCOMOTION - LO
Research Trait



1-15 pts.
Severe abduction with short stride and skating motion

20-35 pts.
Slight abduction with medium stride

40-50 pts.
No abduction with long stride

FORE UDDER ATTACHMENT - FU

Primary Trait



1-5 pts.
Extremely loose

25 pts.
Intermediate strength

45-50 pts.
Extremely snug & strong

FRONT TEAT PLACEMENT - TP

Primary Trait



1-5 pts.
Extremely wide placement on outside of quarter

25 pts.
Centrally placed on quarter

45-50 pts.
Base of teats on extreme inside of quarter

REAR UDDER, HEIGHT - UH

Primary Trait



1-5 pts.
Extremely low

25 pts.
Intermediate height

45-50 pts.
Extremely high

FRONT TEAT LENGTH - LF

Primary Trait



1-5 pts.
1-1/4 inches or smaller

25 pts.
2-1/4 inches

45-50 pts.
3-1/4 inches or longer

REAR UDDER, WIDTH - UW

Primary Trait



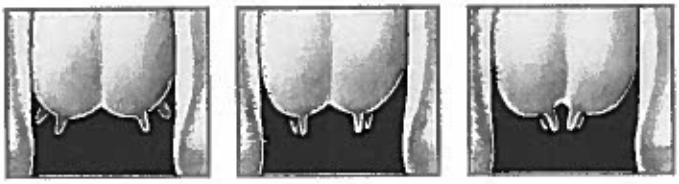
1-5 pts.
Narrow rear udder

25 pts.
Intermediate width

45-50 pts.
Extremely wide rear udder

REAR TEAT PLACEMENT - RT

Primary Trait



1-5 pts.
Extremely wide placement on outside of quarter

25 pts.
Centrally placed on quarter

45-50 pts.
Base of teats on extreme inside of quarter

UDDER CLEFT - UC

Primary Trait



1-5 pts.
Weak cleft

25 pts.
Intermediate

45-50 pts.
Extremely strong cleft

UDDER TILT - UT

Research Trait



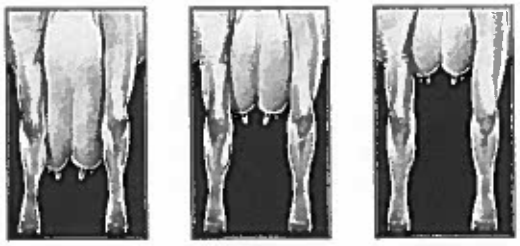
1-5 pts.
Rear quarters deep

30 pts.
Front and rear quarters level

45-50 pts.
Front quarters deep

UDDER DEPTH - UD

Primary Trait



1-5 pts.
Very deep udder floor well below hocks

25 pts.
Udder floor above hocks

45-50 pts.
Extreme height of udder floor above hocks

BODY CONDITION - CS

Research Trait



1-10 pts.

21-30 pts.

41-50 pts.

FINAL SCORE

A cow's final score is based on the five major classification categories or breakdowns of front end and capacity, dairy strength, rump, feet and legs, and udder. The classifier numerically assigns each category a score ranging from 1 to 100 points. The numbers are based on the level of desirability exhibited by individual cows for each category compared to the true-type model. The final score is the sum of the five major breakdown scores weighted as follows:

COWS		BULLS	
Front End & Capacity	15%	Front End & Capacity	40%
Dairy Strength	20%	Dairy Strength	25%
Rump	5%	Rump	10%
Feet and Legs	20%	Feet and Legs	25%
Udder	40%		

In assigning major breakdown scores, the classifier considers such factors as age, number of lactations, and stage of lactation. Major breakdown and final score is expressed numerically. Those numbers correspond with the following brackets:

Excellent [E]	90-97 points	Good [G]	75-79 points
Very Good [VG]	85-89 points	Fair [F]	65-74 points
Good Plus [GP]	80-84 points	Poor [P]	50-64 points

MAJOR BREAKDOWN DESCRIPTIONS

FRONT END AND BODY CAPACITY 15%

The skeletal parts of the cow, with the exception of feet & legs, and rump. Listed in priority order, the descriptions of the traits to be considered are as follows:

Front End: Adequate constitution with front legs straight, wide apart and squarely placed. Shoulder blades and elbows set firmly against the chest wall. The crops should have adequate fullness.

Chest: Deep and wide floor with well-sprung fore ribs blending into the shoulders.

Barrel: Long, with adequate depth and width; spring of rib increasing toward the rear with a deep flank.

Back/Loin: Back should be straight and strong, with loin broad, strong, and nearly level.

Stature: Height including length in the leg bones with a long bone pattern throughout the body structure. Height at withers and hips should be relatively proportionate.

Breed Characteristics: Exhibiting overall style and balance. Head should be feminine, clean-cut, slightly dished with broad muzzle, large open nostrils and strong jaw.

DAIRY STRENGTH 20%

A combination of dairyness and strength which supports sustained production and longevity. Major consideration is given to general openness and angularity while maintaining strength, width of chest, spring of fore rib, and substance of bone with freedom from coarseness. Body condition should be appropriate for the stage of lactation. Listed in priority order, the descriptions of the traits to be considered are as follows:

Ribs: Wide apart. Rib bones wide, flat, deep, and slanted toward the rear.

Width of Chest: Wide, showing capacity for vital organs.

Spring of Fore Rib: Well sprung, expressing fullness and extending outside the point of elbows.

Thighs: Lean, in-curving to flat and wide apart from the rear.

Withers: Sharp with chine prominent.

Neck: Long, lean, and blending smoothly into shoulders; clean-cut throat, dewlap, and brisket.

Skin: Thin, loose, and pliable.

RUMP 5%

The rump should be long and wide throughout with thurls centrally placed to enhance mobility. Listed in priority order, the descriptions of the traits to be considered are as follows:

Rump Angle: Pin bones should be slightly lower than hip bones.

Rump Width: Thurls should be wide apart with adequate pin width.

Vulva: Should be nearly vertical and the anus should not be recessed.

Tail Head: Should set slightly above and neatly between pin bones and be free from coarseness.

FEET AND LEGS 20%

Feet and rear legs are evaluated. Evidence of mobility is given major consideration. Listed in priority order, the descriptions of the traits to be considered are as follows:

Rear legs, Rear view: Straight, wide apart with feet squarely placed.

Locomotion: The use of feet and rear legs, including length and direction of step.

Rear legs, Side view: Moderate set (angle) to the hock.

Feet: Steep angle and deep heel with short, well-rounded closed toes.

Thurl Position: Centrally placed between hip and pin bones.

Hocks: Cleanly molded, free from coarseness and puffiness with adequate flexibility.

Bone: Flat and clean with adequate substance.

Pasterns: Short and strong with some flexibility.

Slightly more emphasis placed on Feet than on Rear Legs when evaluating this breakdown.

UDDER 40%

The udder traits are evaluated. Major consideration is given to the traits that contribute to high milk yield and a long productive life. Listed in priority order, the descriptions of the traits to be considered are as follows:

Udder Depth: Moderate depth relative to the hock with adequate capacity and clearance. Consideration is given to lactation number and age.

Fore Udder: Firmly attached with moderate length and ample capacity.

Rear Udder: Wide and high, firmly attached with uniform width from top to bottom and slightly rounded to udder floor.

Teat Placement: Squarely placed under each quarter, plumb and properly spaced from side and rear views.

Udder Cleft: Evidence of a strong suspensory ligament indicated by adequately defined halving.

Teats: Cylindrical shape; uniform size with medium length and diameter.

Udder Balance and Texture: Udder floor level as viewed from the side. Quarters evenly balanced; soft, pliable and well collapsed after milking.

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Dairy Business Management

2026 All-American Dairy Show Junior Dairy Management Contest

Dairy Business Management Study Guide

Main Types of Business Structures:

- **Corporation –** As a business structure that is owned by several people known often as "stockholders", corporations are recognized as a separate legal entity. Often, a board of directors is elected to make most or all business decisions. Additionally, accurate bookkeeping is required for this type of business structure.
    - **Benefits:** Own property, pay taxes, make contracts, sue individuals, and ownership is easily transferable from one individual to another through the sale of stock
    - **Drawbacks**: Extremely costly to start up, additional taxes are owed if the corporation closes, individuals or other businesses can sue, small corporations may find it difficult to find individuals to sell their stock to, and all income is taxed twice (once as a corporate tax and then shareholders are taxed on profits)
- **S-Corporation –** Displays all the characteristics of a corporation but is taxed like a sole proprietorship with the benefit of offering limited liability.
- **Limited Liability Company (LLC)–** This business structure is neither a partnership nor a corporation and offers many great tax advantages.
    - **Benefits:** Liability of the business is separate than its members (owners), offers flexible management options, and avoids double taxation as the owners are recognized as "self-employed"
    - **Drawbacks:** Extremely expensive to form and require a lot of additional bookkeeping requirements
- **Sole-Proprietorship –** A simple and easy business structure to organize, that offers few government regulations and/or restrictions.
    - **Benefits:** The owner has the power to make all the business decisions, receives all the profits from the business and pays taxes once the income is received
    - **Drawbacks:** Creditors can claim the owners' personal assets for payment on business debts and can hold owners personally responsible for emergencies that occur at the business
- **Partnership –** Business structure that generally consists of two or three business owners
    - **Benefits:** Offers lower start-up costs, can obtain capital immediately, business partner can offer additional support, both monetary and expertise, and all profits made from the business are split among the partners and taxed once the income is received
    - **Drawbacks:** Creditors can claim owner personal assets for business debts; owners can be held personally responsible for emergencies that occur at the business and disputes between partners can occur when managing the business and sometimes end partnerships

Business Planning Tools:

- **Mission & Vision Statements:**
  - **Mission Statements:** A company's mission statement is essentially its statement of purpose. It serves as a guide for all the business decision-making. Owners, leaders and employees are generally the target of the mission. It should help workers within the organization know what decisions and tasks best align with the mission of the company.
    - **Example:** The mission of Center for Dairy Excellence Foundation to build and invest in programs that cultivate and inspire the next generation of producers, consumers, and advocates for the dairy industry.
  - **Vision Statements:** Vision statements are sometimes confused or used synonymously with mission statements. However, vision statements should offer more of a direction and include a perspective of values. A vision might provide direction for the business for the next five to ten years, while also noting a commitment to integrity, transparency, openness and other such values.
    - **Example:** The vision of the Center for Dairy Excellence Foundation is to empower the next generation of the dairy industry.
- **SWOT Analysis:** A major tool that is easy to utilize for business success is completing a SWOT analysis. This tool is used to assess the Strengths, Weaknesses, Opportunities, and Threats of the dairy business. Serious thought must be given when completing this because it shows the owner's holistic view of the business.

Strengths:	Weaknesses:
▪ **Strengths are considered mostly internal** o For example, what do you and your family, employees, and management team bring to the business? ➢ *Your family is very supportive of the time you spend in the business, and you have hired or developed experienced, loyal, and caring employees.* ➢ *Your management team works well together and provides excellent input for the business.* ➢ *Equipment is up-to-date and you have saved the depreciation money to replace outdated equipment.*	▪ **Weaknesses are also considered mostly internal and are the items you will need to address for success of your business** ➢ *Lack of experience in the selected industry* ➢ *Family members do not completely support you in this venture* ➢ *Lack of qualified employees or your business will not support full-time employees* ➢ *Poor decision that is now impacting the business* ➢ *High turnover of employees.* ➢ *Lack of necessary capital for equipment, and/or a high short-term debt load.*
Opportunities:	**Threats:**
▪ **Opportunities are considered mostly external** ➢ *Take advantage of low interest loan packages from various sources* ➢ *Producing a product or idea that has not been previously done in your area* ➢ *Fulfilling a niche market for your local area* ➢ *Expanding operation by adding a lagoon or a new milking facility* ➢ *Hire a summer intern who could become a full-time, successful employee/manager*	▪ **Threats are also considered mostly external. These are threats from outside your business that will directly impact you over and may have very little control.** ➢ *Local regulations negatively impact your business* ➢ *Unforeseen competition (local or foreign)* ➢ *Dissolution of markets, and adverse weather may also have a negative effect on your business* ➢ *Rising interest rates may have a greater impact* ➢ *Heavily leveraged businesses will be greatly impacted by an increase in your interest rates*

Understanding Financial Management:

A series of financial statements are needed to measure progress on a dairy farm. Lenders need these documents to satisfy loan requirements and farmers and managers need them, so they can continually measure progress toward their objectives. Financial analyses can give identical answers to different dairyman who will make different decisions based on the data, depending on their objectives and what they think their alternatives really are.

- **Balance Sheets, Income Statements and Cash Flow Plans –** Whether it is a mom-and-pop farm or a 10,000 dairy, the basic principles of financial business management consistently utilizes these two tools to analyze different aspects of the farm.
    - **Balance Sheet:** used to tell how much of a business is owned, how much collateral can secure additional borrowing, and how far away bankruptcy is (*measures what there is to work with*)
    - **Income Statements:** show whether the business was profitable or not and can be used to estimate debt servings ability (*tells whether enough money is being made to accomplish objectives*)
    - **Cash Flow Plans:** show how much and when money flows through the dairy and helps test the feasibility of changes that might be made in the dairy (*financial road map*)
- **Assets and Liabilities -** When evaluating a business, all financial related items fall into one of 2 categories—Assets or Liabilities.
    - **Asset:** a resource owned by the farm.
        - Examples: land, cash in the bank, supplies, equipment, building structures and money owed to the farm (accounts receivable).
    - **Liability:** debt owed by the farm.
        - Examples: loan payments, equipment payments, mortgage payments, wages, and taxes.
    - Assets and liabilities can be further divided based upon how long the asset will be utilized for or how long the debt will take to repay. This is being done to match up the useful life of the item and the time in which it will take to pay it off (i.e. it would be almost impossible to pay off a $300,000 debt in less than a year).
- The 3 sub-divisions are short-term, intermediate, and long-term for assets and liabilities.
    - **Short-Term** assets/liabilities are under 12 months (an asset will have a useful life of under 1 year and a liability will be paid off in less than a year)
    - **Intermediate** assets/liabilities are classified as 13-120-month investments (1 year-10 years)
    - **Long-Term** assets/liabilities are longer than 10 years
- **Knowing a Farm's Equity –** There are several common ratios utilized to determine financial stability of a farm business. Below is a list of the ratios that are important financial indicators, their definition and how to calculate that ratio. Specifically, the information needed to find these financial indicators is located on income statement and a balance sheet.

Equity: Equity (also referred to as Net Worth), usually refers to the value of "things" where Net Worth refers to the value of a person. Percent Equity, however, is a measure of the assets owned by the business itself. To calculate the equity of a farm and the percent equity, see the formulas shown below:

Assets – Liabilities = Equity

(Assets – Liabilities) ÷ Assets = Percent Equity

- **Current Ratio** - A ratio that measures the liquidity of a business. It shows the ability of the business to pay its current obligations on a short-term basis.
  - **Current Assets ÷ Current Liabilities = Current Ratio**
    - ✓ **890,000 ÷ 252,000 = 3.53:1**
- **Intermediate Ratio** - A ratio that measures the ability of a business to pay its intermediate obligations.
  - **Intermediate Assets ÷ Intermediate Liabilities = Intermediate Ratio**
    - ✓ **1,900,000 ÷ 575,000 = 3.30:1**
- **Net Income** - The funds that a business has left after taking all the expenses away from the total revenue earned.
  - **Income – Expenses = Net Income**
    - ✓ **$3,132,000 – $2,267,000 = $865,000**
- **Solvency: Debt to Asset Ratio –** The measure of the ability of a business, at a point in time, to meet all debt obligations following the sale of all assets. The ratio increases as the business incurs greater levels of debt and decreases as debt is paid off
  - **Total Debts ÷ Total Assets X 100 = Solvency Rate**
    - ✓ **1,802,000 ÷ 7,290,000 X 100 = 24.72%**
  - **Example:** If a farmer has a 20% solvency rate, they are not highly leveraged and can take on more debt if they plan to expand or buy new equipment. If a farmer has a 60% solvency rate, they would be highly advised not to take on more debt because they would have more debt than assets. (Less than 30% is a competitive level)
- **Debt Per Cow –** This is another way of looking at the ability of a dairy farm to meet its debt obligations. Debt per cow indicates how a manager would repay the debt due to cows generating the money needed to make both the principal and interest payments.
  - **Total Debts ÷ (Lactating Cows + Dry Cows) = Debt Per Cow**
    - ✓ **1,802,000 ÷ (425 + 75) = $3,604**
  - **Competitive Levels:**
    - ✓ Less than $3,300 per cow, less than $4,300 per cow during an expansion
  - If debt per cow is too high, it may be experiencing a difficult time in meeting all principal and interest payments. If debt per cow is too low, the management team should carefully asses the operation and consider if moderate investments could increase efficiency and profitability.

All American Dairy Farm Balance Sheet 12/31/2025

ASSETS			LIABILITIES & OWNERS EQUITY	
Current Assets			**Current Liabilities**	
Checking Account	58,000		Accts payable	40,000
Accounts Receivable	207,000		Operating Debt	6,000
Prepaid Expenses	70,000		Current portion of:	
Feed	520,000		Intermediate debt	120,000
Supplies	35,000		Long Term debt	86,000
Total Current Assets:	890,000		Total Current Liabilities:	252,000
Intermediate Assets			**Intermediate Liabilities**	
Dairy Cows	700,000		Machinery & Equipment	375,000
Heifers	450,000		Livestock	200,000
Machinery & Equipment	750,000			
Total Intermediate Assets:	1,900,000		Total Intermediate Liabilities:	575,000
Long Term Assets			**Long Term Liabilities**	
Land & Buildings	4,500,000		Real Estate	575,000
			Buildings & Improvements	400,000
Total Long-Term Assets:	4,500,000		Total Long-Term Liabilities:	975,000
TOTAL ASSETS	7,290,000		TOTAL LIABILITIES:	1,802,000
			Total Equity:	5,488,000
			Total Liabilities + Equity:	7,290,000

All American Dairy Farm Income Sheet 12/31/2025

INCOME	
Description	**Total**
Milk	2,875,000
Cull Cows	215,000
Calves	30,000
Crops	
Govt Receipts	12,000
TOTAL INCOME:	**3,132,000**

EXPENSES			
Description	**Total**	**Description Cont.**	**Total Cont.**
Hired Labor	400,000	Other livestock expenses	10,000
Feed		Crops	
Dairy grain and concentrate	750,000	Fertilizer & lime	50,000
Dairy Roughage	45,000	Seeds & plants	45,000
Machinery		Spray & other crop exp	20,000
Machinery hire/rent	40,000	Crop professional fees	3,000
Machinery repair	100,000	Real Estate	
Fuel, Oil, Grease	90,000	Building/fence repair	42,000
Livestock		Taxes	25,000
Replacement livestock	70,000	Rent & lease	32,000
Breeding	28,000	Other	
Vet & Medicine	80,000	Insurance	20,000
Milk Marketing	95,000	Utilities	52,000
Bedding	50,000	Interest paid	72,000
Milking supplies	40,000	Other professional fees	14,000
Custom Boarding	35,000	Miscellaneous	9,000
rbST expense	50,000		
TOTAL OPERATING EXPENSE: 2,267,000			
NET FARM INCOME: 865,000			

DEPRECIATION	
Machinery Depreciation	120,000
Building Depreciation	60,000
TOTAL DEPRECIATION	**180,000**

Farm size is 500 mature dairy cows: 425 lactating and 75 dry cows. Total milk marketed in 2025 was 12,000,000 lbs. Value of unpaid owner/management & labor in 2025 was $60,000.

Feed and Nutrient Management

JDMC Nutrition Test Study Resources 2026

Please review the articles below to prepare for questions that will be asked on the JDMC Nutrition exam.

Feed Identification:

Become comfortable identifying the following forages/feeds. You may look these up online to see what they look like or, if you are able, obtain actual samples to learn what they feel and smell like.

- Alfalfa Hay
- Orchard Grass Hay
- Timothy Grass Hay
- Sorghum/Sudan Grass
- Wheat Straw
- Corn Silage (processed and unprocessed)
- Ryelage/Rye Silage
- Wheatlage/Wheat Silage
- Alfalfa Haylage
- High Moisture Shell Corn (ground)
- High Moisture Ear Corn (ground)
- Flaked Corn
- Snaplage
- Candy Meal
- Bakery Meal
- Soybean Meal
- Barley
- Corn Gluten Meal
- Canola Meal
- Cottonseed
- Wheat Midds
- Soybean Hulls
- Molasses
- Distillers Grains
- Sodium Bicarbonate
- Salt
- Limestone
- Urea

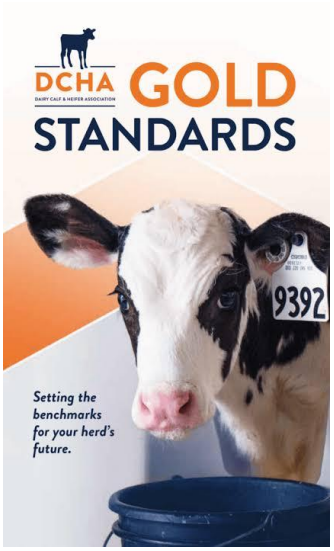
The Transition Period

Questions will be asked about the article linked below:

- https://extension.psu.edu/maximizing-feed-intake-key-for-transition-cow-success

Dairy Calf and Heifer Association (DCHA) 2026 Gold Standards

DCHA updated their Gold Standards for calf and heifer raising this year. Some questions will be asked about information described below:



Health

- Target **scours incidence** in youngstock
    - Pre-weaning (mild): <25%
    - Pre-weaning (severe): <15%
    - Post-weaning to 6 months: <5%
- Target **pneumonia incidence** in youngstock
    - Pre-weaning: <20%
    - Post-weaning to 120 days: <15%
    - After 4 months of age: <5%
- Updated definitions (use these for consistent tracking)
    - **Scours:** runny to watery feces persisting for more than 24 hours, with evidence of dehydration or reduced appetite.
    - **Pneumonia:** two or more abnormal clinical signs (cough, nasal discharge, depression, or increased respiratory rate) plus a fever of 103°F or greater, requiring individual animal treatment.

Newborn Care

- Remove calves from the maternity pen as soon as possible to reduce the risk of injury and illness.
- Navel dipping: dip within 30 minutes of birth and re-dip within 12 hours.
    - Use 7% tincture of iodine.
- Acceptable disbudding methods are paste and hot iron.
    - Paste should be applied within the first few days of life.
    - Hot iron should be performed by 8 weeks of age.

Colostrum

- Collect first-milking colostrum within 2 hours of calving
- Colostrum quality (Brix): 24% for the 1st feeding and 21% for the 2nd feeding.
- Colostrum volume: feed 8-10% of the calf's body weight for the 1st feeding (~3-4 quarts) and 4% of the calf's body weight for the 2nd feeding (~1.5-2 quarts).
- Colostrum timing: provide the 1st feeding within 2 hours of life, and the 2nd feeding within 12 hours after the first feeding.

Nutrition

- Offer clean water starting on day 1 and refresh daily.
- Provide at least 1.8 lb (dry matter) of milk per day to meet nutrient requirements for growth (3.2 quarts twice daily at 13% solids).
- Calf starter should contain at least 18% crude protein.
    - Offer within 1-3 days of life.
    - Replenish daily; replace weekly.
- Don't start weaning before 8 weeks of age.
- Wean over 14 days using a step-down method.
- Recommended weaning age: 70 days.
- If calves are individually housed, delay grouping until at least 7 days after weaning.
- Pre-weaning average daily gain goal: 1.8-2.2 lb/day.
- Daily grain intake goal to begin the weaning process is 2 lbs. for 3 consecutive days.

JDMC Nutrition Test Study Resources 2026

Please review the articles below to prepare for questions that will be asked on the JDMC Nutrition exam.

Forages

- ***(Primarily focus on the Ensiling Process and Harvest Maturity sections)*** ***https://content.ces.ncsu.edu/forage-conservation-techniques-silage-and-haylage-production***

Mycotoxins

- ***(Mold and Fungus Identification Guide)*** ***https://f.hubspotusercontent40.net/hubfs/745395/Alltech%20Mold%20&%20Fungus%20Chart.pdf?__hstc=126399186.4ebc66a7761478cf1a9e958aedf491da.1571035941055.1606638319365.1607477178917.39&__hssc=126399186.6.1607477178917&__hsfp=3212866697&hsCtaTracking=cc8c9eec-b7ae-4a79-bbed-c719b6c2994b%7C44172897-f471-4f0b-be6b-c9a2f635ea2b***
- ***(Warning Signs of Mycotoxins)*** ***https://www.alltech.com/ae-en/blog/9-warning-signs-mycotoxins-your-dairy-herd***
- ***(Manure Scoring)*** ***https://www.alltech.com/node/14821***

Ingredients fed to Dairy Cattle

- https://extension.psu.edu/concentrates-for-dairy-cattle/

Forage ID Resources

- https://quizlet.com/93960030/dairy-feeds-flash-cards/



Sustainability/ Regenerative Agriculture



Environmental Stewardship

EVALUATION PREPARATION GUIDE

VERSION 3



The National Dairy Farmers Assuring Responsible Management (FARM) Program is open to all farms, milk processors and cooperatives, and helps ensure the success of the entire industry by demonstrating to customers and consumers that U.S. dairy farmers are committed to producing the best milk with integrity.

National Milk Producers Federation (NMPF) with support from Dairy Management, Inc. (DMI), established the FARM Program in 2009. Through the Innovation Center for U.S. Dairy, the dairy community has aligned behind FARM as the industry-wide, on-farm social responsibility program. Over the years, the FARM Program has expanded to provide resources and guidelines in its five program areas: Animal Care, Antibiotic Stewardship, Biosecurity, Workforce Development and Environmental Stewardship.

U.S. dairy farmers have a long history of being good environmental stewards. Our challenge is to show customers and consumers how the industry continues to make progress in improving environmental outcomes. The FARM Environmental Stewardship (FARM ES) program area helps track and communicate a farm's environmental achievements.

The online tool, combined with the program's resources, assist farms with pursuing continuous improvement in ways that make business sense. Version 3 of the program focuses on greenhouse gas (GHG) emissions, energy use and nutrient management plans as well as enabling farm-level insights through what-if scenarios.

An optional addition to the FARM Environmental Stewardship evaluation is available, addressing field and dairy-level conservation activities to capture a more holistic sustainability story.

NMPF
NATIONAL MILK PRODUCERS FEDERATION

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Dairy farmers are individually responsible for determining and complying with all requirements of local, state and federal laws.



GOVERNANCE

FARM Environmental Stewardship is reviewed for updates every three years, with scientific updates released between version cycles as needed.

The FARM Environmental Stewardship Task Force is composed of farmers, co-op and processor staff, and other subject matter experts. They guide program development and strategic direction.

The NMPF Environmental Committee reviews recommendations from the Task Force for new metrics and changes in program requirements. Such recommendations are subject to approval from the NMPF Board of Directors.

FIGURE 1

Governance Groups with Percentage of Farmer Representation in Each

NMPF Board of Directors (Approval)	60%
NMPF Environmental Committee (Recommendations)	30%
Environmental Stewardship Task Force (Guidance/Input & Ambassadors)	36%

SECOND-PARTY EVALUATION

A FARM Environmental Stewardship evaluation involves data collection to estimate a farm's environmental footprint. A second-party evaluator is trained to collect on-farm environmental data consistently and impartially. The second-party evaluator also assists in interpreting the results.



HOW OFTEN ARE EVALUATIONS CONDUCTED?

The FARM Program does not require a specific frequency of evaluations. A FARM Program participant (the co-op or processor through which a farm is participating) can work with its facilities to establish a regular cadence for evaluations (e.g. every three years). Grant programs or supply chain projects that facilities opt into may have requirements on how often to conduct evaluations. Evaluations must be scheduled in advance and are not to be conducted unannounced.

WHO CONDUCTS SECOND-PARTY EVALUATIONS?

Second-party evaluations are conducted by certified individuals who complete and pass a training program specific to the current version cycle. Evaluators must retake the online, self-paced training annually to maintain their certification.

THE SCIENCE BEHIND FARM ENVIRONMENTAL STEWARDSHIP VERSION 3

FARM Environmental Stewardship Version 3 uses the **Ruminant Farm Systems (RuFaS) model** as its engine for measuring a farm's GHG footprint. RuFaS is a whole-farm system model to simulate dairy farm production and environmental impact.

As a whole-system, process-based model, RuFaS accounts for physical, chemical, and biologic cycles which enables impacts and changes to be reflected across the whole farm system. By using the farm's location to pull relevant soil, temperature, and precipitation, the baseline footprint as well as "what-if" scenarios are tailored specifically to the farm.

The platform offers the ability to run "what-if" scenario analyses of management, practice, and technology options.

WITH THIS NEW SCIENTIFIC ENGINE, FARM ES WILL BENEFIT OVER TIME

- Updated science to foster continued credibility:
  - Science is peer-reviewed, published, with ongoing scientific journal submissions
  - Full model will be open-source with documentation to support transparency
  - Model will integrate updates over time to stay current with latest research
- Leverages the expertise of researchers from across the country, including from the USDA Agricultural Research Service, Cornell University, University of California Davis, University of Wisconsin–Madison, Colorado State University, and more.

THE DATA NEEDED TO ESTIMATE GHG EMISSIONS AND ENERGY USE INTENSITY INCLUDE

- Milk production records
- Herd data
- Ration information
- Manure management systems
- Energy use

OPTIONAL DATA ENTRIES INCLUDE

- Animal management
- Field practices

Results are offered in pounds of CO_2 equivalent (CO_2e) per pound of Fat- and Protein-Corrected Milk (FPCM). This represents how many GHG emissions are emitted for the farm to produce one pound of FCPM. It includes both emissions that occur at the farm itself (e.g. fuel use) as well as emissions that occurred upstream (e.g. purchased feed production emissions).

Because the results are scaled by pounds of milk, the farm can compare results over time, even when total milk output changes. Since year-to-year improvement can be hard to see, the goal is to capture long term trends, not focus on the yearly ups and downs.





CONSERVATION PRACTICE QUESTIONNAIRE

To further capture a more holistic sustainability story, the FARM program launched the Conservation Practice Questionnaire (CPQ) in 2022 as an optional add-on to the FARM ES evaluation. The questionnaire was developed with stakeholder feedback and on-farm piloting. It addresses areas covered in the dairy industry's 2050 environmental stewardship goals, highlighting field and dairy-level conservation practices including but not limited to:

- Participation in conservation programs like National Resources Conservation Service Environmental Quality Incentives Program (NCRS EQIP) or supply chain projects
- Water recycling and stewardship
- Use of byproducts for bedding or ration
- Use of energy saving technologies like LED lights, variable frequency drives (VFDs), plate coolers, etc.
- Implementation of field-level conservation practices like cover crops, no-till, crop rotation, etc.
- Pest management strategies

Organizations that participate in FARM Environmental Stewardship can use aggregate data from the questionnaire as a lens into the natural resource stewardship of participating dairy farmers and to respond to customer and consumer inquiries. Organizations may choose not to use the CPQ with no impact on its participation in FARM Environmental Stewardship otherwise.

PROGRAM EXPECTATIONS

DAIRY FARMER

- Assist evaluator in completing the evaluation as needed
- Provide data or information that the evaluator requests to the best of the farm's ability
- If records or data are unavailable, note the data gap to the evaluator

EVALUATOR

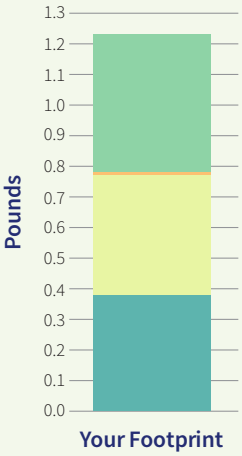
- Complete the FARM Environmental Stewardship Version 3 training to gain competency in conducting evaluations
- Understand relevant FARM resources, including the User Guide and Reference Manual
- Follow all safety guidelines and employ proper biosecurity protocols as set by the individual farmer
- Maintain and safeguard the farm's confidential information
- Communicate evaluation expectation to farmers
- Use reasonable estimates and record assumptions when there are data gaps
- Be polite and courteous
- Share and help interpret results with the dairy farmer

RESULTS

FARM Environmental Stewardship estimates the farm's GHG and energy use footprints. (See Figure 2 for example results.)

FIGURE 2

Example: Your Farm Greenhouse Gas Emissions



Legend

- Feed Production
- On-Site Manure
- On-Site Energy Use
- On-Site Enteric

Emissions Sources	lb CO_2/lb FPCM
Feed Production (excluding LUC)	0.378
On-Site Manure	0.394
On-Site Energy Use	0.012
On-Site Enteric	0.448
Total	1.233

	lb CO_2/lb FPCM
Direct LUC	0.384

THE TOTAL GHG FOOTPRINT IS DIVIDED BASED ON WHERE THE EMISSIONS COME FROM

- Feed production
- On-site enteric (emissions from the cow's digestive processes)
- On-site manure
- On-site energy use

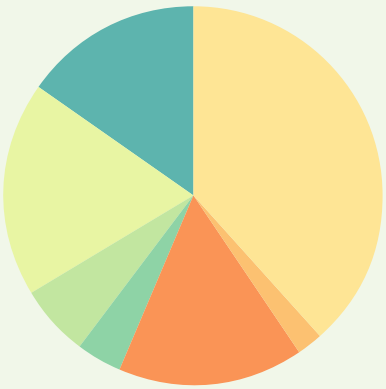
*On-site refers to dairy activities on the farm. If the operation purchases feed and doesn't engage in feed production activities, the output will still generate an estimate for the environmental impacts of the purchased feed.

THE REPORT OFFERS ADDITIONAL INSIGHTS INTO A FARM'S FOOTPRINT

- The **Feed Production Insights** section provides breakdowns of the farm's feed production emissions by ration ingredient.
- The **Relative Contribution to Emissions** graph compares the contribution of each Ingredient to Feed Production Emissions Relative to its Contribution to Dry Matter Intake (DMI). 1.0 means percentage of DMI = percentage of emissions. If an ingredient's ratio is above 1.0, it means that it contributes a disproportionate percentage of emissions compared to how much of the ration it makes up.
- **Homegrown Feed Emissions** section offers insights on emissions and sequestration from crops planted on the farm. The results of this section are based on the model's current calculations, which are undergoing updates.
- **Milk Allocation Factor** represents how much of the GHG footprint is assigned to milk production versus beef production. It is incorporated into the footprint results at the top of the data input list part of the report.
- The **Data Input List** documents the data that was input into the FARM ES report for future reference.

FIGURE 3

Feed Production Emissions by Ration Ingredient



Legend

- Corn Grain, ground
- Corn Silage, mid maturity
- Corn Silage, mature
- Soybean Meal, solvent, 48% CP
- Alfalfa Silage, mid maturity
- Grass Hay, mature
- Wheat Grain, rolled



CONTINUOUS IMPROVEMENT

To further explore potential continuous improvement opportunities, farmers and evaluators can run 'what-if' scenarios in FARM ES Version 3 to consider different management practices and technologies. Farmers can work with their evaluators to change one or more of the data inputs and then see the impact on the footprint results.

The FARM Environmental Stewardship Reference Manual can be used as a guide for identifying continuous improvement opportunities. If results are higher in a particular GHG category, focus on that section of the manual. Each section gives tips and considerations for how you can improve your farm's footprint in ways that make business sense.

The **Dairy Conservation Navigator**, created by DMI, is an online platform, built to consolidate science-based information on dairy conservation topics, practices and technologies that reduce a farm's footprint. The Navigator explains complex sustainability topics through the Learning Hub, which provides training materials and resources to support farm advisors and information sharing. It also features definitions of over 80 common conservation practices and technologies, providing practical insights on their economic and management impacts. Access the Navigator: **https://www.dairyconservation.org/**

EMISSIONS TYPE	RELEVANT REFERENCE MANUAL CHAPTER(S)	CHAPTER PAGE	EXAMPLE TOPIC AREAS COVERED
All	Chapter 2: Moving Forward	Page 8	• Selecting a specialist/vendor • Financing options
Feed Production	Not covered in the Reference Manual	N/A	N/A
On-Site Enteric	Chapter 3: Feed Chapter 4: Productivity	Page 16 Page 38	• Ration formulation • Feeding • Herd health
On-Site Energy Use	Chapter 6: Energy	Page 72	• Energy efficiency options for milking, ventilation and lighting
On-Site Manure	Chapter 3: Feed Chapter 5: Manure	Page 16 Page 58	• Manure storage and treatment options • Ration formulation

AFTER THE EVALUATION

EVALUATION FEEDBACK

The FARM Program values feedback as it considers future updates and resources. After participating in an evaluation, we encourage all dairy farmers and managers to complete a feedback form found on our website: **https://nationaldairyfarm.com/national-dairy-farm-evaluation-feedback-form/**

FARM DATABASE ACCESS

All dairy farms and evaluators have access to review their completed evaluations within the password-secured FARM database. Contact your second-party evaluator or reach out to **dairyfarm@nmpf.org** to create an account.

DATA PRIVACY

The farm's personal information is private. The FARM Program and the Innovation Center for U.S. Dairy only use aggregated, anonymous results in public-facing reports. Collection, protection and use of data is outlined in the FARM Program **Privacy Policy** and **Terms of Service**. Talk to your evaluator to find out more about how your co-op or processor uses FARM Environmental Stewardship data. Some co-ops and processors use aggregated, anonymous results to answer customer questionnaires about on-farm sustainability. Visit the FARM database: **https://eval.nationaldairyfarm.com/**

VERSION 3 CHECKLIST

FARM Environmental Stewardship collects data on milk production, herd data, rations, manure management, and energy use. This data should represent a 12-month period, specified by the evaluator. The following list contains the majority of the data captured in FARM ES Version 3, but some questions trigger follow-up information that may not be captured here:

DATA	DATA SOURCE EXAMPLES
Milk Production • Total annual milk production (lbs) • Annual avg protein and fat content (%)	DHIA, dairy record management system, milk shipment records
Herd Profile • Total adult herd (running herd avg of lactating + dry cows) • Annual avg on-site pre-weaned calves • Annual avg off-site or purchased pre-weaned calves • Annual avg on-site post-weaned heifers • Annual avg off-site or purchased post-weaned heifers • Adult animals sold (%) • Adult animals that died (%)	Herd management software (DairyComp, PCDart)
Herd Profile: Optional • Times milked per day (default - 3) • Breed (default – Holstein)	Herd management software (DairyComp, PCDart)

DATA	DATA SOURCE EXAMPLES
Animal Management: Optional • Still birth rate (default – 6.5%) • Avg days of weaning (default – 60 days) • Calves born as replacements (default – 40%) • Age of first breeding (default – 40 days) • Heifer breeding method (default – ED) • Heifer breeding method details (conception, detection rate) • Cow breeding method (default – ED) • Cow breeding method details (conception, detection rate) • Calving details (dry period) • Breeding and milk production culls • Other culling information	Herd management software (DairyComp, PCDart)
Feed • Lactating cow ration feed ingredients • For each ingredient: — Amount fed (lbs/day) either as-fed or dry matter basis — Homegrown, purchased, or both	Nutritionist, feed management software, dairy record management system
Feed: Optional • Calf ration details • Heifer ration details • Dry cow ration details	Nutritionist, feed management software, dairy record management system
Nutrient Management Plan • If the farm has a plan, type of written plan — Whether farm implements and maintains it	Nutrient management plan
Manure *For each manure management system/animal group* • Housing type • Months per year (if relevant) • Bedding type • Pen type • Barn type • Manure handling • Manure separation (solid-liquid separation) • Manure treatment (anaerobic digestion) • Manure storage	Nutrient management plan, anaerobic digester company, solid-liquid separator manufacturer
Energy • Annual total electricity use • Annual total fuel use • Annual total renewable energy generated (solar, wind, digester) • Annual total carbon/renewable energy credits	Utility bills, energy usage logs, purchase records
Field Management: Optional • Manure details, nutrient content (if known) • Fertilizer details, nutrient content • For each field, need five years of crop data including: — Number of acres managed — Planting, harvest, manure application, fertilizer application, and tillage information	Nutrient management plan, field management software



MEASURING PROGRESS

The FARM Environmental Stewardship program area helps track and communicate a dairy farm's environmental achievements. The program provides tools and resources for farmers to measure and improve their environmental footprint.

INDUSTRY LEADERSHIP

The Innovation Center for U.S. Dairy uses anonymized data from FARM Environmental Stewardship to measure the industry's progress toward meeting industry-wide environmental goals. As a result, the industry can continue to demonstrate dairy's leadership on environmental issues.

SUPPLY CHAIN COMMUNICATIONS

Dairy buyers ask cooperatives and dairy processors to provide aggregated farm-level data on GHG emissions to help them measure the environmental footprint of their products. Cooperatives and dairy processors can use FARM ES to collect on-farm GHG emissions data in a consistent and streamlined way; helping dairy farmers and the entire dairy value chain demonstrate our commitment to environmentally responsible production.

MANURE MANAGEMENT GLOSSARY

FARM Environmental Stewardship defines manure management and handling practices by the descriptions below. Use the table as a guide, since system names vary by region. Links are included for additional information on each management practice.

MANURE MANAGEMENT/ HANDLING SYSTEMS	DESCRIPTION
Daily Spread	Manure is collected and land applied within 24 hours. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Solid Stack	The storage of manure, typically for a period of several months, in unconfined piles or stacks. Manure can be stacked due to the presence of bedding material or loss of moisture by evaporation. This choice should be chosen for separated manure solids that are stacked for a short period of time before use. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Composting	Biological oxidation of solid waste, including manure, usually with bedding or another organic carbon source. See below for different types of composting. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Slurry Storage Underfloor	Collection and storage of manure usually with little or no added water, typically below a slatted floor in a barn, usually emptied a few times a year. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Slurry with Crust	Manure stored in structures like a basin or tank, usually between 5% and 15% dry matter. There is little added water, and a natural crust is allowed to form. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Slurry without Crust	Manure stored in structures like a basin or tank, usually between 5% and 15% dry matter. There is little added water, and a natural crust is NOT allowed to form. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Covered Anaerobic Lagoon	Manure stored in structures like a basin or tank with a cover, usually with a solids volume of less than 5%. Typically, the storage found in systems where effluent from a solid-liquid separator is stored or a dairy that uses flushing to clean alleys and pens. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Uncovered Anaerobic Lagoon	Manure stored in structures like a basin or tank, usually with a solids volume of less than 5%. Typically, the storage found in systems where effluent from a solid-liquid separator is stored or a dairy that uses flushing to clean alleys and pens. Uncovered lagoons are open to the air. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Cap and Flare	Cap and flare systems involve a gas-tight plastic membrane covering the surface of manure storage structures to capture emissions and keep rainwater out. Gas collected from under the cover can be combusted in a flare to reduce greenhouse gas emissions. https://ecommons.cornell.edu/server/api/core/bitstreams/8586a845-6ed2-4c50-bab8-03b46a95d02b/content
Anaerobic Digester	Encourages the bacterial decomposition of manure in the absence of oxygen, producing biogas, which is collected and utilized. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Flush	Flush systems use water to flush manure from alleyways. The water and manure are then collected, and solids are usually separated with mechanical or gravity systems before the wastewater is recycled and used again. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9165779/

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Learn more at the FARM website: **nationaldairyfarm.com**.

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FARM ENVIRONMENTAL STEWARDSHIP USER GUIDE

VERSION 3





FARMERS ASSURING FARM™ RESPONSIBLE MANAGEMENT





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INTRODUCTION

U.S. dairy producers are proactive environmental stewards who have tended for decades with great care to their land and water. Producing a gallon of milk in 2017 compared to 2007:

- 30% less water
- 21% less land
- 19% smaller carbon footprint[1]

To continue and enhance its environmental efforts, the dairy industry has set ambitious goals including to become greenhouse gas (GHG) neutral by as early as 2050. Launched in 2009, the National Dairy Farmers Assuring Responsible Management (FARM) Program helps earn the public's trust, demonstrating that dairy farmers share their values and are committed not only to quality animal care, but also to ensuring safe wholesome milk, high standards of environmental stewardship, and exceptional work environments. The program is managed by National Milk Producers Federation in partnership with Dairy Management, Inc. and the Innovation Center for US Dairy.



1 Capper, Judith L, and Roger A Cady. "Effects of Improved Performance in the U.S. Dairy Cattle Industry on Environmental Impacts between 2007 and 2017." OUP Academic, Oxford University Press, 17 Oct. 2019, academic.oup.com/jas/article/98/1/skz291/5581976

ABOUT FARM ES

Launched in 2017, FARM Environmental Stewardship is a farm-level environmental assessment and customer assurance program. The core FARM ES evaluation provides a comprehensive estimate of greenhouse gas emissions on dairy farms. The program provides tools and resources for farmers to measure and improve their footprint. Data can be aggregated by dairy cooperatives and processors for reporting emissions to dairy buyers.

The Conservation Practice Questionnaire (CPQ) is an optional add-on to the FARM Environmental Stewardship evaluation that addresses field and dairy-level conservation activities to capture a more holistic sustainability story.

WHY FARM ES

The FARM ES tool provides a unified platform built by and for the U.S. dairy community powered by credible, peer-reviewed science. U.S. dairy farmers are actively involved in shaping the FARM ES program. It unifies industry response to customer requests for sustainability data, helping to streamline sustainability measurement into one program. The evolution to FARM ES Version 3 enables more farm level insights through updated science.

Operational Insights

- FARM ES can highlight opportunities for cost-savings. For example, if the farm's greenhouse gas footprint is high in a certain area, like energy use, there might be ways to gain efficiencies that also reduce expenditures.
- FARM ES Version 3 allows for robust scenario analysis, so a farm can analyze the impacts of potential management or practice changes, including the potential impact on productivity.

License to Operate

- Aggregating data from FARM ES at the cooperative, processor and national levels help demonstrate dairy's environmental benefits to customers and consumers.

Gateway to Opportunity

- There are financial and technical assistance opportunities to help farms implement environmentally beneficial practices and technologies, including grants, cost-share, carbon markets and more. FARM ES can help farmers assess if an opportunity is right for their farm through the scenario analysis abilities of Version 3.

Farmers and evaluators are encouraged to share feedback about the evaluation by visiting nationaldairyfarm.com.

FARM ES VERSION 3 UPDATE

FARM ES Version 3 uses the Ruminant Farm Systems (RuFaS) model as its engine for measuring the farm's GHG footprint. RuFaS is a whole-farm system model to simulate dairy farm production and environmental impact. As a whole-system, process-based model, RuFaS has many benefits:

- Accounts for physical, chemical, and biologic cycles which enable impacts and changes to be reflected across the whole farm system.
- Provides ability to run "what-if" scenario analyses of variable management, practice and technology options.

With this new scientific engine, FARM ES will benefit over time:

- Updated science that continues to foster credibility as the RuFaS model evolves.
  - Science is peer-reviewed, published, with ongoing scientific journal submissions.
  - Full model will be open-source with documentation to support transparency.
- Leverages the expertise of researchers from across the country, including from USDA Agricultural Research Service, Cornell University, University of California Davis, University of Wisconsin Madison, Colorado State University, and more.

Minimum Data Versus Optional Data

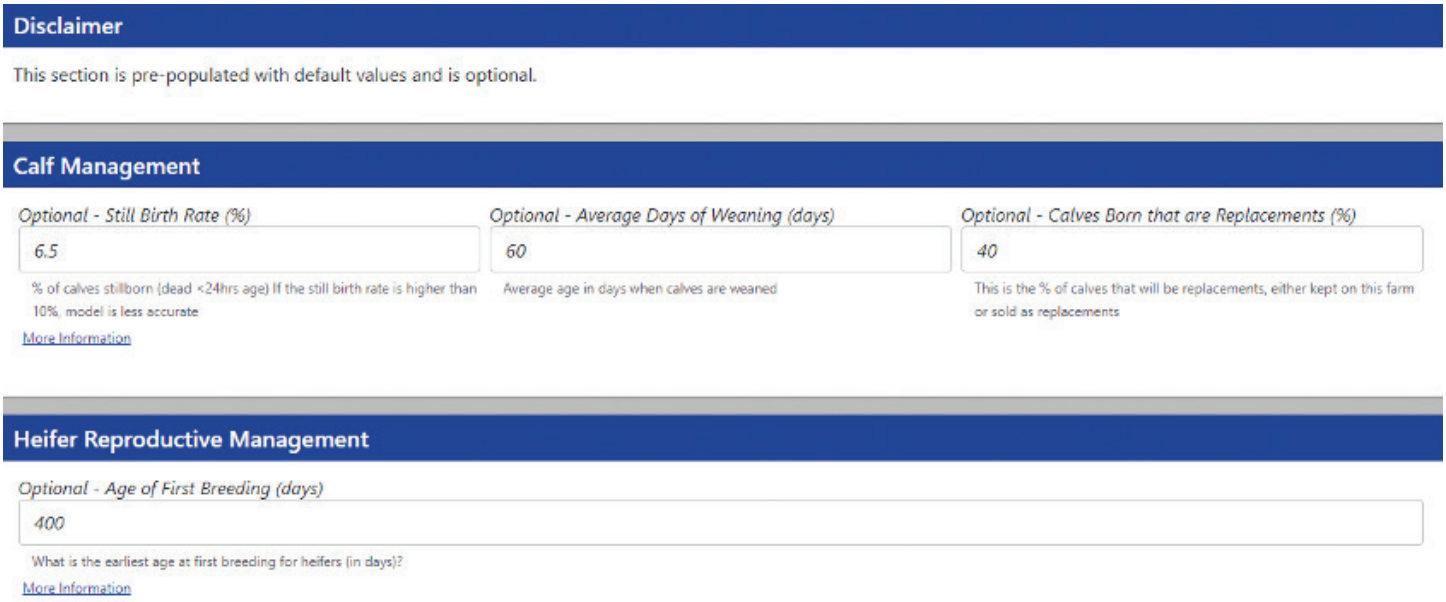
The evaluation includes minimum and optional data inputs. All minimum data inputs are required for FARM ES Version 3 to run and accurately estimate a farm's footprint. If farms are interested, they can add data to the optional modules, including the Animal Management and Field modules. The optional sections are provided for farms that want to get a more tailored footprint; they are **not required** to complete FARM ES Version 3.

Once data is submitted, the model will take about 5–15 minutes to generate results depending on the herd size of the farm.

Evaluation Period

Users should enter data from a consistent 12-month period. It does not necessarily have to reflect a calendar year. The same 12-month period (for example, April 1 to March 31) should be used each time the farm has a FARM ES evaluation completed.

If entering data in the optional field management section, it is recommended that the 12-month period entered follows the natural cadence of planting and harvesting, for ease of entering data. For example, if a farm double crops, it might be easier to enter dates beginning after harvest of the winter crop and before planting of the spring crop, rather than Jan 1 to Dec 31.



Example of Optional Data Entry Fields

PRODUCTION & HERD INFO

Summary of Data Needs

- Milk Production
- Herd Profile
  - Herd size/demographics
  - Animals sold/culled
  - Optional inputs include times milked per day and breed

In the Background

- The RuFaS model uses the production and herd information to inform all other modules within the model. It uses these numbers to establish a herd and understand the flow of animals through the farm system to establish how nutrients flow through the feed, manure, and field modules.
- Milk production is used to normalize results (e.g. giving results per pound of milk produced) and determine efficiency of the herd.
- The model estimates what percent of the total adult herd is dry on the backend, which is why it is important to include all dry and lactating animals in the total herd number.

Common Challenges

- If the farm only has its crude protein content, subtract 0.19% to estimate the true protein percent that is needed in the model.

Tips

- Before the ES evaluation, ask the farm to pull together milk production and herd management information. This can come from either DHIA, PC Dart, Bovisync, DairyComp or other records.
- FARM ES distinguishes between animals raised on-farm versus off-farm to ensure the model correctly understands which feeds, manure management and other data inputs are applied to which animals. The model will use regional assumptions for the animals raised off-site. Off-site heifers and calves must be entered to calculate the footprint.
- Animals that 'died' includes animals euthanized and animals 'sold' are animals that were sold for beef or were otherwise culled.
- The farm's milk marketer would also be able to provide milk production data. Additional sales records may be consulted as needed.
- If the farm has a robotic milker, pull the average number of milkings for the herd and round to the closest integer.

MILK PRODUCTION

Operations can find production, herd, and animal sales information in the DHIA report or other dairy record management systems. The farm's milk marketer would also be able to provide milk production data. Report total milk production for a consistent year, including pounds sold, used on-farm or other, as well as the average milk protein content and milk fat content.

Total Annual Milk Production
Total annual pounds of milk shipped, used on-farm or other.

_____lbs

Average Milk Protein Content
Allowed range is 1.0 to 5.0
Enter true protein content. If only crude protein is available, subtract 0.19% to estimate the true protein percent.

_____%

Table continued on next page

Average Milk Fat Content
Allowed range is 1.8 to 6.0

_____%

HERD PROFILE

Where relevant, users can override default inputs if they have that information for their farm and would like to input it. Use running herd averages for pre-weaned calves and post-weaned heifers, not the annual total.

On-farm and Off-farm

- On-farm: Calves and heifers raised on the farm where milk production is occurring.
- Off-farm: Calves and heifers raised elsewhere such as at a neighbor's farm down the road or another operation many miles away.

Total Adult Herd
Use the running herd average of lactating and dry cows.
DairyComp305 command: count id>0 for lact>0

_____cows

OPTIONAL Times Milked Per Day

_____
Default: 3

On-site Pre-weaned Calves

_____calves

Off-site or Purchased Pre-weaned Calves

_____calves

On-site Post-weaned Heifers

_____heifers

Off-site or Purchased Post-weaned Heifers

_____heifers

OPTIONAL Breed
If the herd is a mix or contains other breed(s), pick breed that most closely matches animal size. If the herd is 50-50 split, choose Holstein.

☐ Holstein ☐ Jersey
Default: Holstein

OPTIONAL Average Mature Body Weight
The average body weight of cows in their 3rd+ lactation within the herd.

_____lbs
Holstein default: 1,630 lbs.
Jersey default: 900 lbs.

Adult Animals Sold
Total sold cows divided by average adult animals herd size. Does not include heifers.

_____%

Adult Animals Died
Total cows that died divided by average adult animals herd size. Does not include heifers.

_____%

ANIMAL MANAGEMENT

This entire section is optional; pre-filled defaults are provided. It records calf management, reproductive management, and culling information.

Summary of Data Needs (entire section optional)

- Calf Management
- Heifer Reproductive Management
  - Heifer Breeding Method
- Adult Herd Reproductive Management
  - Cow Breeding Method
- Culling

In the Background

- The RuFaS model uses herd and reproductive management information to support its understanding of the flow of animals through the farm. There is also correlation between reproductive management and efficiency of the animals in the herd which can impact manure and enteric emissions.

Tips

- Farms interested in completing this section should be prepared to input herd data including calf management, heifer and cow breeding methods, and culling rates. Operations can find herd information in dairy record management systems.
- Before the ES evaluation, ask the farm to pull together herd and reproduction management information. These can come from DairyComp, PCDart or similar record systems.
- DairyComp codes are provided for some inputs to help with data collection.

CALF MANAGEMENT

Still Birth Rate
% of calves stillborn (died <24hrs age). If the still birth rate is higher than 10%, model is less accurate.
DairyComp command: events (choose calf table)

_____%
Default: 6.5

Average Days of Weaning
Average age in days when calves are weaned.

_____days
Default: 60

Calves Born that are Replacements
% of calves born that are replacements for the herd (will return to the farm/under farm ownership). If the farm breeds only to beef and sells all the calves, please leave the default number here.

_____%
Default: 40

HEIFER REPRODUCTIVE MANAGEMENT

Age of First Breeding

What is the earliest age at first breeding for heifers (in days)?
DairyComp305 command: graph agenda by bred1 for lact=0
If only known in months, multiply by 30 to estimate in days.

_____days
Default: 400

HEIFER BREEDING METHOD

Heifer Breeding Method

Select the heifer breeding method. If natural service (bull bred), please choose estrus detection.
ED = estrus detection (heat detection); TAI = timed artificial insemination only; SynchED = combination of estrus detection and timed AI

For more information on heifer breeding protocols: https://www.dcrcouncil.org/wp-content/uploads/2018/12/Dairy-Heifer-Protocol-Sheet-Updated-2018.pdf

☐ ED ☐ TAI ☐ SynchED
Default: ED

If user selects 'ED', the following questions appear:

Heifer ED Detection Rate

Detection rate of heifers bred to ED (Estrus or heat detection rate; also known as insemination rate).
DairyComp305 command: bredsum\y read insemination risk column

_____%
Default: 90

Heifer ED Conception Rate

Conception rate of heifers bred to ED
DairyComp305 command: bredsum\y

_____%
Default: 55

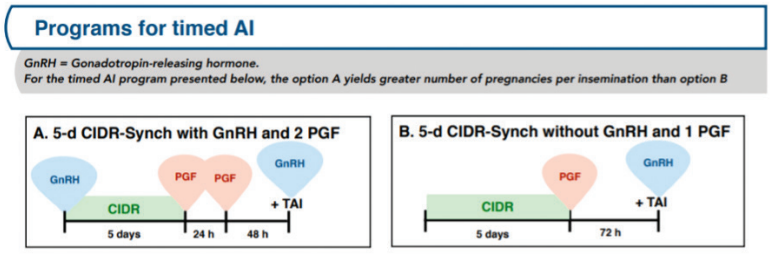
If user selects 'TAI', the following questions appear:

Heifer TAI Conception Rate (%)

Conception rate of heifers bred to TAI or synch program.
DairyComp305 command: bredsum\y

_____%
Default: 60

Heifer TAI Protocol



https://www.dcrcouncil.org/wp-content/uploads/2018/12/Dairy-Heifer-Protocol-Sheet-Updated-2018.pdf

☐ 5dCG2P ☐ 5dCGP
Default: 5dCG2P

Table continued on next page

If user selects 'SynchED', the following questions appear:

Heifer ED Detection Rate

Detection rate of heifers bred to ED.
DairyComp305 command: bredsum\y read insemination risk column

_____%
Default: 90

Heifer ED Conception Rate

Conception rate of heifers bred to ED
DairyComp305 command: bredsum\y

_____%
Default: 55

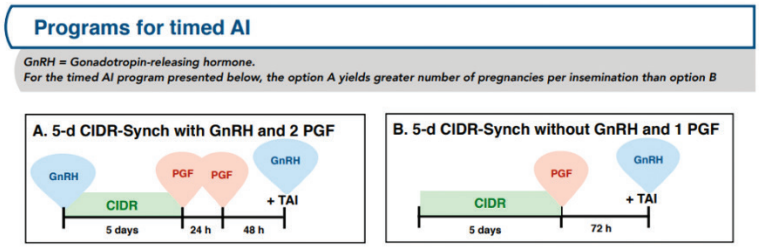
Heifer TAI Conception Rate (%)

Conception rate of heifers bred to TAI or synch program
DairyComp305 command: bredsum\y

_____%
Default: 60

Heifer TAI Protocol

☐ 5dCG2P ☐ 5dCGP
Default: 5dCG2P



https://www.dcrcouncil.org/wp-content/uploads/2018/12/Dairy-Heifer-Protocol-Sheet-Updated-2018.pdf

ADULT HERD REPRODUCTIVE MANAGEMENT

Cow Breeding Method

Select the cow breeding method. If natural service (bull bred), please choose estrus detection.

For more information on cow breeding protocols: https://www.dcrcouncil.org/wp-content/uploads/2019/04/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf

☐ ED ☐ TAI ☐ TAI/ED
Default: ED

*see next table for additional data inputs dependent on which Breeding Method is selected

Days into Pregnancy when Cow is Dried Off (Days)

Days carried calf when dried off. If unsure, consider how many months a cow is dry and subtract from 282 (the average length of gestation of a Holstein in days)

_____days
Default: 218

Table continued on next page

Length of the Transition Before Calving
Days spent in close-up group.

_____days
Default: 30

Calving Interval
Enter the average number of days between calvings in the herd.
DairyComp305 command: sum cint

_____days
Default: 404

ADULT HERD REPRODUCTIVE MANAGEMENT | COW BREEDING METHOD

If user selects 'ED', the following questions appear:

Estrus Detection Rate
% insemination rate, percentage of in heat animals that would be detected in the ED programs.
DairyComp305 command: bredsum\evXX (change the XX to the voluntary waiting period and read insemination rate column)

_____%
Default: 40

Estrus Detection Conception Rate
%, conception rate of breedings from heat detection. (activity, painting, standing heat, etc.)
DairyComp305 command: bredsum\o

_____%
Default: 35

Voluntary Waiting Period
The earliest days in milk when a cow would be bred.
DairyComp305 command: graph dim by bred1

_____days
Default: 50

If user selects 'TAI', the following questions appear:

TAI Conception Rate
Enter the overall TAI conception rate.
DairyComp305 command: bredsum\o

_____%
Default: 35

Voluntary Waiting Period
If "TAI" is chosen for cow, it is days in milk at which the first cow is bred to TAI.
DairyComp305 command: graph dim by bred1

_____days
Default: 80

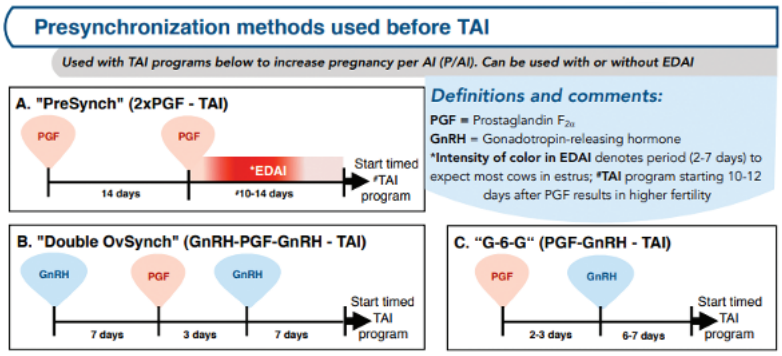
Table continued on next page

Timed AI – PreSynch Program

Cow PreSynch Program

The synchronization protocol used for the first insemination for cow in TAI program.

☐ PreSynch
☐ DoubleOvSynch ☐ G6G
Default: G6G



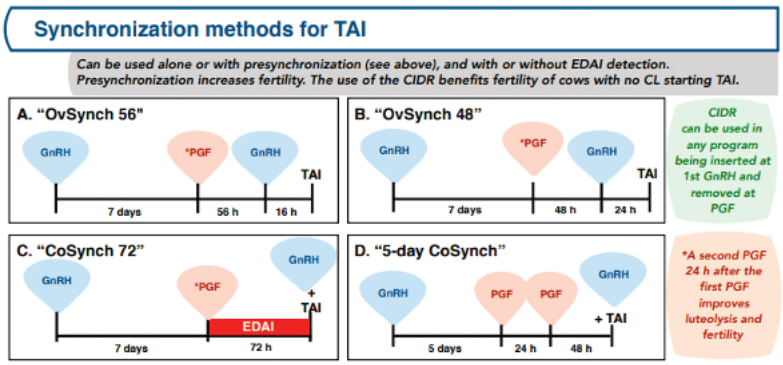
https://www.dcrcouncil.org/wp-content/uploads/2019/04/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf

Timed AI – OvSynch Program

OvSynch Program

Choose timing of last GnRH shot in relation to when the last PG (lut) shot was given.
OvSynch56 = 56hrs after PG, GnRH is given

☐ OvSynch 48 ☐ OvSynch 56
☐ CoSynch 72 ☐ 5d CoSynch
☐ None
Default: OvSynch 56



https://www.dcrcouncil.org/wp-content/uploads/2019/04/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf

Timed AI – ReSynch Program

Resynch Program

The resynch protocol for cow that is diagnosed open at pregnancy. TAIafterPD = GnRH is given to start OvSynch program when cows are open at preg check. TAIbeforePD = GnRH is given one week prior to preg check diagnosis, cows are continued on program if open. PGFatPD = PG (lut) shot given to open cows at preg check.

☐ TAIafterPD ☐ TAIbeforePD
☐ PGFatPD ☐ None
Default: TAIafterPD

If user selects 'TAI/ED', the following questions appear:

Is the first service a combination of TAI/ED or just TAI?

☐ TAI ☐ TAI/ED
Default: TAI

Table continued on next page

Voluntary Waiting Period

Default values are different depending on which program is selected for first service.
DairyComp305 command: graph dim by bred1

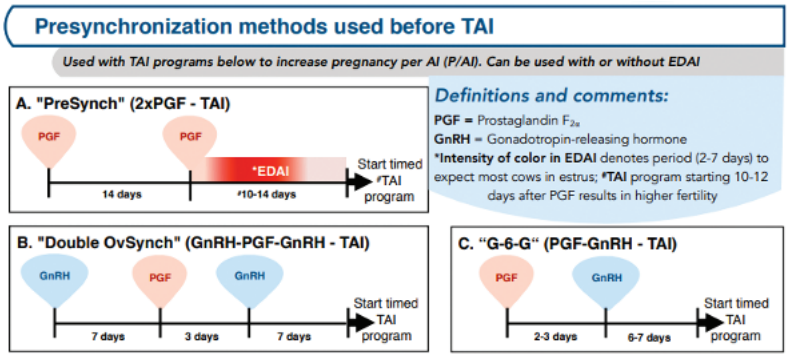
_____days
Default: TAI–80, TAI/ED–50

If user selects 'TAI' in the question above, the following is displayed:

PreSynch Program

If synchronization protocol is used for first breeding, choose which is used.
PreSynch (2PG followed by OvSynch), Double OvSynch, G6G

☐ PreSynch
☐ DoubleOvSynch ☐ G6G
Default: G6G

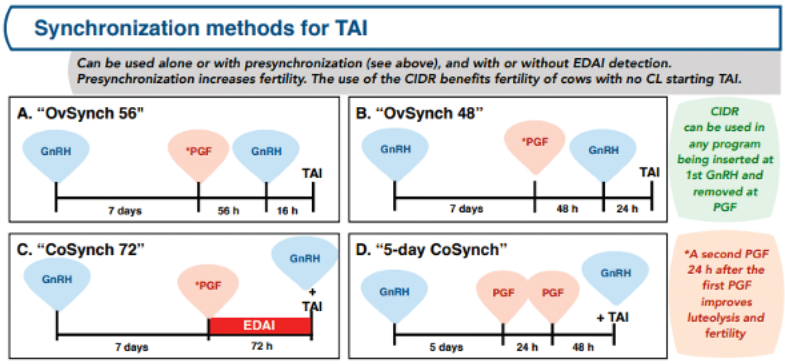


https://www.dcrcouncil.org/wp-content/uploads/2019/04/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf

OvSynch Program

Choose timing of last GnRH shot in relation to when the last PG shot was given.
OvSynch56 = 56hrs after PG, GnRH is given

☐ OvSynch 48 ☐ OvSynch 56
☐ CoSynch 72 ☐ 5d CoSynch
☐ None
Default: OvSynch 56



https://www.dcrcouncil.org/wp-content/uploads/2019/04/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf

OvSynch Conception Rate

DairyComp305 command: bredsum

_____%
Default: 35

If user selects 'TAI/ED' in the question above, the following is displayed:

Voluntary Waiting Period

DairyComp305 command: graph dim by bred1

_____days
Default: 50

Table continued on next page

PreSynch Program
If synchronization protocol is used for first breeding, choose which is used.
PreSynch (2PG followed by OvSynch), Double OvSynch, G6G

☐ PreSynch
☐ DoubleOvSynch ☐ G6G
Default: G6G

OvSynch Program
Choose timing of last GnRH shot in relation to when the last PG shot was given.
Ovsynch56 = 56hrs after PG, GnRH is given

☐ OvSynch 48 ☐ OvSynch 56
☐ CoSynch 72 ☐ 5d CoSynch
☐ None
Default: OvSynch 56

Latest Days in Milk in Which First Service Would Occur?
Days in milk when the TAI program for first service ends and the last cow is bred.

_____days
Default: 80

Estrus Detection Rate
Insemination rate, percentage of in heat animals that would be detected in the estrus detection/activity monitoring programs.
DairyComp305 command: bredsum\evXX (change the XX to the voluntary waiting period and read insemination rate)

_____%
Default: 40

Estrus Conception Rate
Conception rate of breedings from heat detection (activity, painting, standing heat, etc.).
DairyComp305 command: bredsum\o

_____%
Default: 35

OvSynch Conception Rate
DairyComp305 command: bredsum\o

_____%
Default: 35

The ReSynch Protocol for Cow That is Diagnosed Open at Pregnancy in the TAI Program
TAIafterPD = GnRH is given to start OvSynch program when cows are open at preg check. TAIbeforePD = GnRH is given one week prior to preg check diagnosis, cows are continued on program if open. PGFatPD = PG (lut) shot given to open cows at preg check.

☐ TAIafterPD ☐ TAIbeforePD
☐ PGFatPD ☐ None
Default: TAIafterPD

CULLING

BREEDING AND MILK PRODUCTION CULLS

Age when Replacement Heifers are Culled if Not Pregnant
Age when replacement heifers are culled for failing to be confirmed pregnant.

_____days
Default: 550

Days in Milk when Cows are Made DNB for Not Getting Pregnant
Days in milk when the decision is made to stop breeding a cow because she has failed to become pregnant.

_____days
Default: 300

Milk Production Minimum for Culling
If a cow is not pregnant, because she has been marked DNB (do not breed) or won't conceive, at what milk production is she culled?

_____lbs/day
Default: 44

Table continued on next page

CULL RATE BY LACTATION

Cull rate for Lactation 1
Likelihood of being culled in lactation 1
For DairyComp users: events for lact =1 (choose by month; then lact =2, then lact>2)

_____%
Default: 16.9

Cull rate for Lactation 2
Likelihood of being culled in lactation 2
For DairyComp users: events for lact =1 (choose by month; then lact =2, then lact>2)

_____%
Default: 23.3

Cull rate for Lactation 3
Likelihood of being culled in lactation 3
For DairyComp users: events for lact =1 (choose by month; then lact =2, then lact>2)

_____%
Default: 30.1

Cull rate for Lactation 4
Likelihood of being culled in lactation 4
For DairyComp users: events for lact =1 (choose by month; then lact =2, then lact>2)

_____%
Default: 40.8

OTHER CULLS

While culling reasons are not recorded on every farm, approximations can be used and should add to 100%. Within RuFaS these reasons are linked with the likelihood of removal from the herd on a specific days in milk.

Culled for Mastitis
% of cull cows left for mastitis.
DairyComp305 command: econ (dead cow report – option 9)

_____%
Default: 24.39

Culled for Feet and Legs
% of cull cows left for feet and legs.
DairyComp305 command: econ (dead cow report – option 9)

_____%
Default: 16.33

Culled for Injury
% of cull cows left for injury.
DairyComp305 command: econ (dead cow report – option 9)

_____%
Default: 28.83

Culled for Disease
% of cull cows left for disease.
DairyComp305 command: econ (dead cow report – option 9)

_____%
Default: 13.91

Culled for Udder
% of cull cows left for udder.
DairyComp305 command: econ (dead cow report – option 9)

_____%
Default: 6.45

Unknown/Other Cull
% of cull cows left for other reasons.
DairyComp305 command: econ (dead cow report – option 9)

_____%
Default: 10.09

FEED

The focus of this section is on the lactating herd ration breakdown. Each feed ingredient should be entered in the ration breakdown table. Rations for other animal classes are pre-filled with regional defaults that can be overridden if desired.

Summary of Data Needs

- Lactating Herd Ration
  - Lactating herd ration breakdown by ingredient.
  - Option to simplify by using regional byproduct mix and mineral mix.
- Optional data includes rations for other animal classes (dry, heifer, calf).

Entering Data

- For each ingredient, select the type of ingredient (concentrate, forage, mix or mineral).
- Select the ingredient from the dropdown or search for a feed ingredient by typing.
- Give the average daily amount fed in either as-fed or dry matter basis.
- Specify if it is purchased, homegrown, or both.
- Methane-reducing feed additives can be specified following the lactating herd ration.
- Grass or alfalfa pasture can be specified under forages for pasture-based systems.

In the Background

- The RuFaS model takes information about rations to inform animal growth, productivity, manure output, and enteric emissions.
- The ration breakdown also relates to feed production emissions because it tells FARM ES how much of each ingredient the herd consumes.

Tips

- Before the ES evaluation, ask the farm to contact its nutritionist for a ration printout.
- Don't forget to add individual minerals or add the "mineral mix" from the "mixes" section.
- If after entering information, the total DMI looks off, consider adding to 'byproduct mix' or 'mineral mix' as appropriate.
- Definition of homegrown for the purpose of FARM ES: ration ingredients from crop production where the dairy operation has operational control over crop production decisions. This can mean crop production happening on the dairy itself, or on a related LLC or entity in which the dairy owner has part ownership.

Common Challenges

- Estimated amounts fed are acceptable. When full ration information is unknown, focus on the forages and corn grain, then enter byproduct mix for the remainder.
- If multiple rations on farm, please take a weighted average of the rations and dry matter intake (DMI). If this is not feasible, enter the high cow ration.

Ration	DMI (lbs/day)		Average Days in Ration		Total Lactating Days		Time-weighted DMI (lbs/day) (Total this column to find the overall average)
High	50	X	150	/	300	=	25
Low	30	X	150	/	300	=	15
					Total		40

LACTATING COW RATION

Feed Ingredient	Amount Fed (lbs/day)	As-fed or Dry Matter Basis?	Homegrown, Purchased, Both?
Lactating Cow Feed Additive	☐ None ☐ 3NOP ☐ Monensin (ionophores)		

REPLACEMENT AND DRY ANIMALS

CALF FEED

The default calf feed assumes an average of 50% milk and 50% calf starter over the course of the pre-wean period. This comes out to about 5lbs of starter intake at weaning and 1 gallon of whole milk twice a day.

Feed Ingredient	Amount Fed (lbs/day)	As-fed or Dry Matter Basis?	Homegrown, Purchased, Both?

HEIFER RATION

This section is pre-populated with a regional default ration that can be overridden/edited if desired.

Feed Ingredient	Amount Fed (lbs/day)	As-fed or Dry Matter Basis?	Homegrown, Purchased, Both?

DRY COW RATION

This section is pre-populated with a regional default ration that can be overridden/edited if desired.

Feed Ingredient	Amount Fed (lbs/day)	As-fed or Dry Matter Basis?	Homegrown, Purchased, Both?

MANURE

Summary of Data Needs

- Nutrient Management Plan
- Manure Management
  - For all on-site animals (lactating, dry, heifer, and calves): housing type, bedding, manure handling, separation (if applicable), and storage/treatment.

Entering Data

- If manure is managed differently throughout the year, enter details for each system along with how many months per year it is used. Note that only two different ways can be accommodated (e.g. eight months in way #1, and four months in way #2).
- To make sure that manure management has been specified for all animals, FARM ES has a running total of the "number of animals assigned to a manure management system" as well as the "total number of on-site animals". The evaluation form will help to identify if any animal's manure has not yet been accounted for within the data entry.
  - For dry cows, note that there is no need to specify the number of animals. The RuFaS model will simulate what percentage of the herd is dry.

In the Background

- The RuFaS model takes the housing and manure management system information to inform manure output, manure nutrient content, and manure emissions.
- Over time, manure decomposes and releases greenhouse gases, including methane and nitrous oxide, during that process. The amount and rate of emissions depends on volume, storage, management, and nutrient content of the manure.
- The boundary of the manure section of FARM ES is handling and storage. The emissions factor for manure management does not cover emissions after the manure is applied to a field. Emissions after land application are incorporated in the crop/feed production emissions category.
- Manure hauling, application, and cropping methods are accounted for in feed emissions. For purchased feeds, this would be included within the emission factor used. For homegrown feeds, farmers have the option to enter details on their manure application within the cropping section of FARM ES.



Tips

- The manure section is designed to flow like a conversation with the farm. Evaluators are recommended to ask about how animals in each animal group (calves, heifers, etc.) are housed, their bedding material, how manure is collected, then stored and treated.
- For lactating cows, if manure from the holding area and/or feed alley is handled differently, then details on holding area manure management will be needed.
- For farms using pasture, some of the otherwise required questions about manure handling, bedding, etc. have been eliminated as they are not applicable.
- Some selections trigger additional data entry needs, which are detailed later in this document.
- The farm's Nutrient Management Plan or Comprehensive Nutrient Management Plan may contain details on manure management.

Common Challenges

- The farm has a Manure Management Plan (MMP) instead of a Nutrient Management Plan (NMP) or a Certified Nutrient Management Plan (CNMP):
  - All three of these are covered in the broad FARM ES umbrella of a Nutrient Management Plan. These acronyms are regulatory distinctions of NMPs depending on the size of dairy and the state where it's located. Generally, a CNMP applies to Concentrated Animal Feeding Operations—though some smaller farms need one depending on how they handle manure. NMPs will be the most common; generally applicable to most size dairies above a certain threshold. MMPs vary—some states have them for smaller dairies.
- The farm is using a manure management system that is not in FARM ES today:
  - Contact dairyfarm@nmpf.org and someone from the FARM program will discuss the best way to enter the on-farm system into the model.
- Differentiating between a slurry and an anaerobic lagoon:
  - The best distinction of an anaerobic lagoon is one where there is some treatment and deliberate water addition (ie. if manure is flushed out of the barns, if water is added to vacuum it, if there is an solid liquid separation system, etc.). In a case where the only water added is rainwater and maybe wash water (not flush water), the manure pit is likely best described as a slurry.

NUTRIENT MANAGEMENT PLAN

FARM ES asks about the use of Nutrient Management Plans in alignment with the U.S. Dairy Stewardship Commitment.

Does the farm have a written Nutrient Management Plan? ☐ Yes ☐ No

If Yes, the following questions appear:

Which type(s) of written Nutrient Management Plan does the farm have? ☐ NMP ☐ CNMP ☐ MMP

Does the farm maintain the Nutrient Management Plan? ☐ Yes ☐ No

Maintained means it is reviewed regularly and updated as needed. Indicate 'Yes' if the NMP is reviewed at least every five years to determine if updates are needed. State or local regulations may require the plan to be updated more frequently.

Does the farm implement the Nutrient Management Plan? ☐ Yes ☐ No

Implementation means that the farm follows the NMP's guidance around nutrient testing, nutrient application, recordkeeping and any other requirements.

MANURE MANAGEMENT

Information needed for each Animal Class:

Number of Animals _____

Housing

If pasture is selected, the below questions will not appear, however users will have to specify manure management information for the holding area. If the user selects compost bedded pack or deep bedding >1 month, users will not have to enter bedding type.

☐ Pasture ☐ Free stall
☐ Tie stall ☐ Dry lot/open lot
☐ Compost bedded pack barn
☐ Deeping bedding > 1 month
☐ Deep bedding < 1 month

Months per Year _____

If different systems are used at different times within a calendar year, enter how many months per year manure is managed in this way.

Bedding Type ☐ Sand ☐ Straw ☐ Sawdust ☐ Manure solids ☐ None

Manure Handling ☐ Manual scraper ☐ Alley scraper ☐ Flush

Manual scraping should be chosen for any type of manure removal that involves a vehicle (skidsteer scraping, vacuum cleaner, etc.).

Table continued on next page

Separation before Treatment/Storage, if applicable
Select up to 2 solid-liquid separation methods.

- ☐ None
- ☐ Sand lane/gravity lane
- ☐ Setting basin
- ☐ Weeping wall ☐ Roller press
- ☐ Belt press ☐ Sloped screen
- ☐ Screw press
- ☐ Rotary screen ☐ Custom

Storage/Treatment
If separation occurs, then only liquid manure management options will appear.

- ☐ Daily spread ☐ Solid stack
- ☐ Composting
- ☐ Slurry storage underfloor
- ☐ Slurry with crust
- ☐ Slurry without crust
- ☐ Open lot/dry lot
- ☐ Covered anaerobic lagoon
- ☐ Uncovered anaerobic lagoon
- ☐ Cap and flare
- ☐ Anaerobic digester

OPTIONAL Storage Time
Enter number of days between emptying manure storage.

_____days

For lactating cows only: Is manure from the holding area handled differently?
If yes, the same questions will appear for holding area manure management.

☐ Yes ☐ No

Some manure management systems trigger additional data inputs. Those are included here for awareness:

If This is Selected	This Input Appears
Housing Type: Composted Bedded Pack Barn	Tillage Frequency per Day
Housing Type: Pasture	Hours per Day Months per Year
Housing Type: Dry/Open Lot	Specify Feed Alley/Parlor Manure Management
Storage/Treatment: Composting	Composting Type (Intensive Windrow, Passive Windrow, or Static Pile) Turning Frequency

If the Storage/Treatment is an anaerobic digester:

Post-digestion Separation?

☐ Yes ☐ No

IF USER SELECTS 'YES': Post-digestion Separation Details

☐ Setting basin
☐ Weeping wall ☐ Roller press
☐ Belt press ☐ Sloped screen
☐ Screw press
☐ Rotary screen ☐ Custom
☐ None

Effluent Management?

☐ Uncovered lagoon
☐ Covered lagoon

If Custom Solid Liquid Separation, the following questions appear:

Separator Custom Name

Percent Dry Solids _____

Total Solids Removal Efficiency for Separator _____

Volatile Solids Removal Efficiency for Separator _____

Nitrogen Removal Efficiency for Separator _____

Total Ammoniacal Nitrogen Removal Efficiency for Separator _____

Phosphorus Removal Efficiency for Separator _____

Potassium Removal Efficiency for Separator _____

Vermifiltration and LWR systems can be entered through a custom "Separation before Treatment/Storage'. The following values are provided for guidance, but please check with the system operator or engineer.

Separator Custom Name	Vermifiltration	Livestock Water Recycling (LWR)
Percent Dry Solids	0.20	0.35
Total Solids Removal Efficiency for Separator	0.70 to 0.97*	0.92
Volatile Solids Removal Efficiency for Separator	0.87	0.83
Nitrogen Removal Efficiency for Separator	0.84	0.83
Total Ammoniacal Nitrogen Removal Efficiency for Separator	0.84	0.83
Phosphorus Removal Efficiency for Separator	0.84	0.83
Potassium Removal Efficiency for Separator	0.15	0.15

*Solids removal efficiency can vary. Please confirm with system operator or engineer.



ENERGY

Summary of Data Needs

- Energy Usage
  - Covers annual energy usage for the year
  - Percent used on dairy activities
- Renewable Energy Generation
  - Info on renewable energy generated by the farm, if applicable
- Carbon Trading
  - Any sold offsets/insets in the year, if applicable

Entering Data

- If the farm is completing the crop section of FARM ES, then the total energy use for the operation (dairy and cropping) should be entered along with the estimated percentage used for dairy activities. Dairy operation energy use includes heating water, milking, cleaning, scraping, fans, grinding and mixing. Fuel use for manure spreading is NOT included in dairy activities.
- If the farm does not grow its own feed or if it grows its own feed but is NOT completing the field section of FARM ES, then users can enter energy usage for the dairy operation only. In this case it is also acceptable to enter total usage and specify the percentage used for dairy activities.

In the Background

- FARM ES Version 3 contains GHG emissions factors for electricity and fuels that account for on-site and upstream emissions (i.e. emissions from producing the electricity or fuel). The annual electricity and fuel usage is multiplied by the emission factors to estimate the total GHG emissions.
- The RuFaS model is developing an energy layer. FARM ES will be able to use the RuFaS energy layer when it becomes available.
- For renewable energy:
  - When the farm owns the Renewable Energy Certificate (REC), the annual renewable energy usage is multiplied by the emission factor for renewable energy.
  - If the farm generates renewable energy and uses on site, but has SOLD the REC, that electricity is considered standard grid electricity for the purpose of the GHG footprint.
- Information about carbon trading is used by dairy cooperatives and processors when aggregating farm-level GHG footprints to adhere to corporate GHG standards.



Tips

- Before the ES evaluation, ask the farm to collect electricity/fuel bills for the past year. Many electric utilities offer an annual summary upon request.
- The farm is likely to know if it is participating in any carbon markets (e.g. LCFS, voluntary carbon market, inset credits with a downstream customer, etc.), but it may not be aware of the total metric tons sold in the evaluation period. The farm may need to reach out to get that information from the appropriate contact, for example, the digester developer for LCFS credits.

Common Challenges

- The farm does not know its fuel usage for the year:
  - Use expenditure and typical price to estimate the amount used
    - For example, if the average price of electricity is $0.12 per kWh and the farm's expenditure for the reporting year was $48,000, then the total annual usage was approximately 48,000/0.12= 400,000 kWh.
  - Reference a FARM ES evaluation on a farm of somewhat similar size and style. Use that farm's propane use as a proxy estimate.
  - If the farm has a sense of fuel use from a previous year that can be used as an estimate.
- The farm is not able to determine the percentage of energy used for the dairy operation versus cropping:
  - An estimated percentage is acceptable
  - Look at electricity and fuel use in the winter months when there are no cropping activities. Use that to estimate for the months of year.
- Depending on the type of carbon credits, the farm may not be sure if it is an inset or an offset. If it is unable to get that information, enter "unsure" for answering the inset/offset question.



ENERGY USAGE

	Amount used in 12 month period	% on dairy activities
Electricity Do not include electricity generated from solar/ wind/digester if it is exported or sold off-site. Include if it is used on the dairy.	_____kWh	_____%
Diesel	_____gallons	_____%
Biodiesel	_____gallons	_____%
Propane	_____gallons	_____%
Natural Gas	_____therm or ccf	_____%
Gasoline	_____gallons	_____%
Fuel Oil	_____gallons	_____%

RENEWABLE ENERGY

Annual solar energy generated on-site	_____kWh
Does the farm own the REC associated with the solar energy?	☐ Yes ☐ No
How much of the solar energy is used on-site?	_____kWh
Annual wind energy generated on-site	_____kWh
Does the farm own the REC associated with the wind energy?	☐ Yes ☐ No
How much of the wind energy is used on-site?	_____kWh

Table continued on next page

If the farm has an anaerobic digester: Does the farm own the carbon credits, REC or other carbon/energy credits associated with the digester?	☐ Yes ☐ No
RNG generated by digester	_____MMcf
RNG generated by digester used on-site	_____MMcf
Electricity generated by digester	_____kWh
Electricity generated by digester used on-site	_____kWh

CARBON TRADING

Has the farm sold any carbon emission reduction credits this year?	☐ Yes ☐ No
If yes, how many tons of CO2e were sold as credits during the evaluation period?	_____metric tons
If known, were the carbon reduction credits sold as insets or offsets?	☐ Insets ☐ Offsets ☐ Unsure
Has the farm sold any credits related to carbon sequestration this year?	☐ Yes ☐ No
If yes, how many metric tons of sequestered CO2e were sold as credits during the 12 month evaluation period?	_____metric tons
If known, were the carbon sequestration credits sold as insets or offsets?	☐ Insets ☐ Offsets ☐ Unsure

FIELD

This module is optional for FARM ES Version 3. The field management section requires a minimum of five years of historical data. Users should be prepared to enter this data for all their fields if they are interested in this module.

Summary of Data Needs (entire section optional)

- Manure Sources
- Fertilizers Used
- Field Activities for five years
  - Dates and info on tillage, planting, manure/fertilizer applications, and harvest

In the Background

- The RuFaS model takes information about nutrient management through fertilizer and manure information to inform soil conditions for each crop.
- The model also takes into account weather conditions, on a daily time step, and tillage practices to further inform the modeled conditions of each crop type.

Tips

- Before the ES evaluation, ask the farm to pull field records or connect with its crop manager to pull this information in advance. As a reminder, FARM ES needs five years of historical data to provide accurate crop data.
- If the farm uses a different tillage type than included in the list, select the one that most closely represents what happens on the farm. Consider the depth and amount of mixing that occurs.

SUMMARY OF DEPTH AND MIXING ASSUMPTIONS WITHIN RUFAS FOR EACH TILLAGE TYPE

Tillage Type	Depth (in)	Mixing (%)
Subsoiler	14	0.7
Moldboard Plow	6	0.95
Coulter Chisel Plow	6	0.5
Cultivator	4	0.3
Seedbed Conditioner	2	0.1
Disk Harrow	1	0.5

- Intercropping is not supported—do not enter crops with overlapping planting/harvest dates.
  - Therefore, a mixture of grass/alfalfa cannot be planted in FARM ES V3. Based on the initial seed mix, please choose either grass or alfalfa.
- Although each individual field can be entered in FARM ES V3, it is recommended that evaluators and farmers try to combine similar rotation and crop types on the farm for ease of data entry.
  - For example, if there are actually 50+ fields that are all in corn silage and tend to go through a corn silage rotation, please enter all of these individual fields as one "field" within V3.
- A rotation should be captured for each crop that is harvested.
  - If a farm harvests alfalfa silage and corn silage and they are in a rotation, it will be necessary to include a representative rotation that will result in two "fields" even if their rotations are identical though opposite.
- Not all fields across a rotation receive fertilizer or manure on the same day or are planted/harvested on the same day, nor does this happen the same date year after year. Try to pick a date in the middle of that time frame that is representative.

Common Challenges

- The farm does not have five years of historical crop data. If this is the case, the farm cannot complete this section at FARM ES and should consider starting to record the data for future use in FARM ES.
- The farm does not have a standard rotation across fields.
  - Rarely do farms use the exact same rotation. A generalized rotation can be used to simplify data entry.
  - For example, some fields undergo a corn silage—alfalfa rotation, but the number of years in alfalfa depends on how thin the crop becomes or when the change is made back from corn silage depends on yields. Talk to the producer to try to estimate an average rotation on the farm.
- The simulation will not work properly if the year of planting is not included. This is especially important for crops that are perennials (alfalfa and grass). In these cases, an additional year or two of data must be included beyond the five years minimum that are required such that planting can be captured.
  - For example, if data is being entered for an alfalfa—corn rotation in 2024. Corn might be planted in 2023 and 2024, and alfalfa harvested in 2022, 2021, 2020 and 2019 because it was planted in 2019. Even though it is six years of data, the model needs to capture the alfalfa being planted in 2019.



MANURE SOURCES

Define the manure sources used on the fields over the year. User will then be able to select them in the Crops section. Users must name each manure source (i.e. “calf bedding compost” or “cow slurry”) so it is easy to identify later in the evaluation when specifying field application.

Name	
Liquid or Solid?	☐ Liquid ☐ Solid
Does the farm know the amount of N, P, and K in the manure? (e.g. % composition) If the farm has a manure sample analysis yielding % Nitrogen, Phosphorous and Potassium or NMP that indicates how many lbs of N, P, and K applied, please select ‘Yes’.	☐ No, use default %NPK ☐ Yes, %NPK known ☐ Yes, know rate (lb/acre) of NPK application per crop

If user selects ‘Yes, %NPK known’, the following question appears:

N	_____%
P	_____%
K	_____%

FERTILIZER USED

Entering Data: Define the fertilizer used on the fields over the years. Users will then be able to select them in the Crops section. Users can also name each fertilizer (e.g. “spring application”) to help track the nutrient content or any other helpful identification.

Name	
Fertilizer Mix	☐ Nitrogen (100% N, no P or K) ☐ Triple 15 (15% N, 15% P, 15% K) ☐ Potash (100% K) ☐ Custom

If user selects ‘Custom’ for Fertilizer Mix, the following questions appear:

Does the farm know the amount of N, P, and K in the fertilizer? (e.g. % composition)	☐ Yes ☐ No

Table continued on next page

If user selects 'Yes', the following question appears:

N _____%

P _____%

K _____%

CROPS

Entering Data: This section captures field activities over the five years.

In this section, cropping activities (planting, manure application, harvest, etc.) will be specified for the past five years.

1. Start by specifying which field(s) information is being entered for. It is recommended to combine similarly managed fields of the same crop/rotation.
2. Then, for that field(s), enter five years of cropping information. Once one year is entered, users can duplicate that information for the prior year. If duplicating a year, be sure to check that the last date entered doesn't go beyond the end of the simulation (for example, if 2023's data was copied into 2024 and it had harvest for corn silage set in mid-September, but this evaluation is being submitted on August 1, users will need to delete the activities from the field management section that go beyond the date of the evaluation).
3. Then enter a new set of field(s) and repeat the process of entering five years of cropping information.

How many acres are planted/managed like this?
Group fields that have the same crops and similar management for this section.
Enter the crop as what it will be harvested as, for example "corn silage".

_____acres

Year _____

Activity Type

- ☐ Planting ☐ Harvesting
- ☐ Manure Application
- ☐ Fertilizer Application
- ☐ Tillage

If the user selects 'Tillage', the following section appears:

Tillage Type
There is a limited number of tillage types here, please choose the tillage that best represents what occurs on the farm accounting for the depth and amount of mixing that occurs.

- ☐ Subsoiler
- ☐ Moldboard Plow
- ☐ Coulter Chisel Plow
- ☐ Cultivator
- ☐ Seedbed Conditioner
- ☐ Disk Harrow ☐ Strip Till

Tillage Date _____

If the user selects 'Planting', the following section appears:

Planting Date _____

Crop Planted _____

What is the cutting height used for the last crop harvested?
If tilled before overwintering, enter 0, but otherwise enter amount of stubble or growth prior to planting next crop (for example if there's 12 inches of cereal rye that was roller-crimped, enter 12).

_____inches

If user selects a variety of wheat, rye or triticale, the following question appears:

Is this a cover crop? ☐ Yes ☐ No

If the user selects 'Manure Application', the following section appears:

Manure Source (choose from Manure Sources created previously)

Application Rate
For manure sources where the user said they know the rate of NPK applied per crop, the evaluation will ask for lb/acre for N, P, and K.

_____gallons/acre for liquid; tons/acre for solid

Application Method
If fertigating, please make decision based on timing and method of fertigation (ie, pivot during growing season = sidedress, subsurface drip prior to growing = injection).

☐ Injection ☐ Broadcast
☐ Sidedress ☐ Dragline

Application Date
For daily spread specify start and end dates.

_____

If user selects 'Injection', the following question about depth is asked:

Depth _____ inches
Default: 6

Percentage of Field Covered
Given we have asked users to combine similar fields of the same crop, this number can vary. For example, if all corn silage was ground together, but some fields (~1/3) receive manure in the fall and the other 2/3 receive a spring application, please indication % as such.

_____ %
Default: 100

If the user selects 'Fertilizer Application', the following section appears:

Fertilizer Application

(choose from Fertilizer Applications created previously)

Application Rate
For fertilizers where the user did not enter the %NPK, the evaluation will ask for lb/acre for N, P, and K.

_____lbs/acre

Application Method

☐ Broadcast ☐ Sidedress
☐ In Furrow

Application Date

_____

If user selects 'In Furrow', the following question about depth is asked:

Fertilizer Injection Depth

_____ inches
Default: 6

If the user selects 'Harvest', the following section appears:

Harvest Date

_____

Yield
Enter wet yield for bushels/acre for grains, tons/acre for hay, silage, and baleage.

_____bushels/acre
or tons/acre

Dry Matter at Harvest/Storage

_____%

If user entered a perennial crop (alfalfa or tall fescue grass):

Is this the final year?
Entering "yes" will kill the crop so that the next crop can be planted.

☐ Yes ☐ No

INTERPRETING RESULTS

FARM ES results can be viewed in the FARM database portal and exported as a PDF to be mailed or emailed. FARM evaluators are required to share the results with the farm. It is highly recommended that evaluators review the results together with the farm to discuss the report and answer any questions.

Understanding the Results

Results are offered in pounds of CO2 equivalent (CO2e) per pound of FPCM. This represents how many GHG emissions are emitted for the farm to produce one pound of fat-and-protein corrected milk. It includes both emissions that occur at the farm itself (e.g. fuel use) as well as emissions that occurred upstream (e.g. purchased feed production emissions).

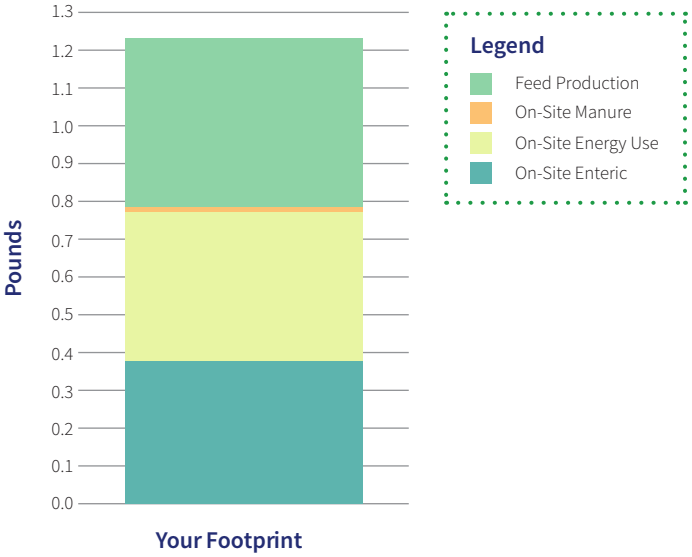
Because the results are scaled by pounds of milk, the farm can compare results over time, even when total milk output changes. Users record the very first set of footprint results as the farm's baseline. Since year-to-year improvement can be hard to see the goal is to capture long term trends, not focus on the yearly ups and downs.

Tips

- Carbon dioxide equivalent (CO2e) is used as a standard unit for measuring carbon footprints. It expresses the impact of each different greenhouse gas in terms of the amount of carbon dioxide (CO2) that would create the same amount of warming over a 100-year period.
- There are three main types of greenhouse gases emitted from dairy farming: methane, nitrous oxide, and carbon dioxide. Each GHG has a different impact on the atmosphere, which is taken into account when converting to CO2e.
- FARM ES uses IPCC AR6 global warming potential values (27.2 for methane; 273 for nitrous oxide). However, feed production emissions are currently only available in AR5.

Your Farm Greenhouse Gas Emissions

lb CO2e/lb FPCM produced



Emissions Sources	lb CO2/lb FPCM
Feed Production (excluding LUC)	0.378
On-Site Manure	0.394
On-Site Energy Use	0.012
On-Site Enteric	0.448
Total	**1.233**

	lb CO2/lb FPCM
Direct LUC	0.384

FARM ES RESULTS ARE DIVIDED INTO FOUR CATEGORIES

Feed Production

- Feed production emissions are currently modeled using county-specific information about crop production practices and transport. Future FARM ES updates will pull in emissions from the farm's unique crop production practices—if the farm chooses to input these—into the total footprint. Information about homegrown feed production emissions are captured in a separate area of the output report.
- The FARM ES results also display emissions from land-use change (LUC), the process of converting land from one use into another.
- If the operation purchases or doesn't grow its own feed the tool will still estimate the environmental impacts of producing the purchased feed.

Manure Management

- Emissions that occur during storage and treatment of manure through biological processes.

Enteric Emissions

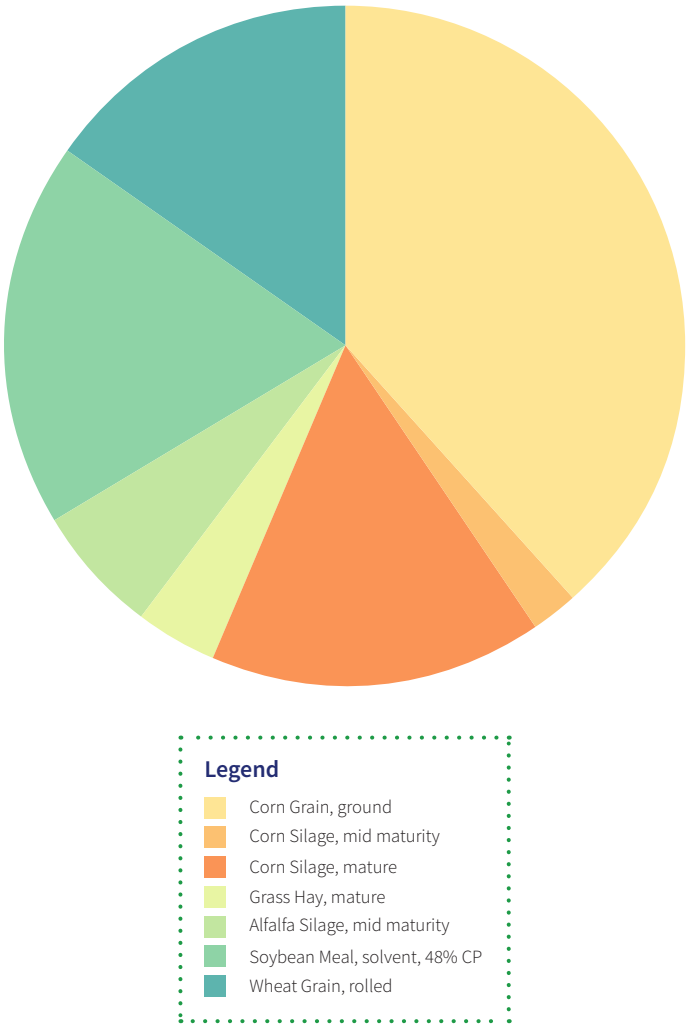
- Emissions directly from the cow that are created during digestion.

Energy Use

- Emissions directly from burning fuels and indirectly from electricity use. FARM ES also captures the lifecycle emissions from mining/manufacturing of energy sources.

GAS TYPE BREAKDOWN

The FARM ES results offers a breakdown of emissions by gas type (methane, nitrous oxide, carbon dioxide). Due to rounding, GHG emissions by gas type may not sum to total GHG emissions. Gas type breakdown has been estimated for feed production, it is not derived from the FoodS^3 model.



OTHER AREAS OF THE FARM ES REPORT

- The **Feed Production Insights** section provides breakdowns of the farm's feed production emissions by ration ingredient. This is based on the purchased feed emissions factors; it does not take into account homegrown feed practices.
- The **Relative Contribution to Emissions** graph compares the contribution of each Ingredient to Feed Production Emissions Relative to its Contribution to DMI. 1.0 means the percentage of DMI equals the percentage of emissions. If an ingredient's ratio is above 1.0, it means that it contributes a disproportionate percentage of emissions compared to how much of the ration it makes up.
- **Homegrown Feed Emissions** section offers insights on emissions and sequestration from crops planted on the farm. The results of this section are based on the model's current calculations, which are undergoing updates. Therefore, organizations should be cautious in using this section's results for Scope 3 emissions disclosures.
- **Milk Allocation Factor** represents how much of the GHG footprint is assigned to milk production versus beef production. It is incorporated into the footprint results at the top of the data input list part of the report.
- The **Data Input List** documents the data that was input into the FARM ES report for future reference.

LB CO2e/LB FPCM			
Emissions Source	Baseline	Scenario 1	Difference
Feed Production	0.378	0.378	0
On-Site Manure	0.439	0.439	0
On-Site Energy	0.012	0.012	0
On-Site Enteric	0.448	0.353	-0.095
Total	**1.278**	**1.183**	**-0.095**
Annual Milk Production	-	-	0%
Homegrown Feeds:			
Homegrown Feed Emission (excluding energy)	0.1	0.1	0
Carbon Sequestration	-0.014	-0.014	0

NEXT STEPS

Learning About Opportunities for Reduction

- Farmers and evaluators can run 'what-if' scenarios in FARM ES Version 3. Users can change any one or more of the data inputs and see what the results would be.
- The FARM ES Reference Manual, found at nationaldairyfarm.com, captures different science-based ideas for reducing emissions in ways that also benefit the business.
- General considerations for reducing emissions:
  - Enteric emissions
    - Improving herd productivity and feed efficiency are two of the most cost-effective avenues toward reducing enteric emissions while also improving the farm's bottom line.
    - Methane-reducing feed additives may be a good fit for some farms.
    - Key support includes the farm's nutritionist, veterinarian, and other herd health specialists.
  - Manure Management
    - Different types of storage and treatment systems contribute to GHGs differently. Generally, manure stored as a solid result in less emissions than manure stored as a liquid. It is important to recognize that GHG emissions are only one consideration in manure management: cost, labor availability, water quality outcomes, and other feasibility issues are chief concerns in making decisions about manure management.
    - Another opportunity is optimizing ration formulation, especially protein, to mitigate manure ammonia and nitrous oxide emissions.
    - Key support include a farm's local extension office, certified agronomists, engineers, and other consultants.
  - Energy Use
    - Opportunities for reducing energy use include using energy efficient technologies, performing regular equipment maintenance, and other best management practices.
    - Key support includes the farm's utility company, they may offer free or low-cost energy audits.
  - Feed Production
    - For homegrown feeds, effectively reducing GHG emissions will depend on the farm's soil type, crops grown, management priorities, and other factors. Some practices to consider include cover cropping, reduced tillage, and reviewing nutrient management.



Technical and Financial Assistance

- The FARM website has a searchable database of technical and financial assistance opportunities at state and federal levels: https://nationaldairyfarm.com/conservation-practice-resources/
- Some cooperatives and processors participate in grant programs, supply chain partnerships or other conservation projects that can benefit farmers. Evaluators should ask about whether their organization participates in any programs for interested farmers.
- There are emerging marketplaces for carbon reductions and ecosystem services. There are many factors to consider before a farm participates in an environmental marketplace. To learn the basics about how carbon markets function, evaluators could consider the articles available through https://decode6.org/.
- Newtrient LLC provides a wide array of support to dairy farmers and cooperatives. Learn more at: https://www.newtrient.com/
- Dairy Conservation Navigator is an online platform created by the U.S. Dairy Checkoff that consolidates science-based information on conservation topics. It also provides information on the practices and technologies that can reduce a dairy farm's environmental footprint. Learn more at: https://www.dairyconservation.org/
- For additional support, evaluators and farmers can reach out to the farm's local extension office, NRCS office, soil and water conservation district, state dairy association or other relevant conservation organizations.

Feedback

- Farmers and evaluators are encouraged to give feedback about the FARM ES evaluation and training program. Feedback can be provided by visiting nationaldairyfarm.com or emailing dairyfarm@nmpf.org.



GLOSSARY

BREEDING PROTOCOLS	DESCRIPTION
Estrus Detection (ED)	Estrus detection (ED), commonly known as heat detection, is the identification of cows in estrus. Estrus is a period every month when a cow is receptive to reproduction. It can be determined when cows demonstrate certain behaviors, including receptivity to mounting. https://dairy.extension.wisc.edu/articles/estrus-detection-estrus-detection-aids
Timed AI (TAI)	Timed artificial insemination (TAI) synchronizes ovulation of ovarian follicles through synchronization (i.e. OvSynch) protocols. These treatments reduce dependence on observation-based heat detection and provide a way to ensure that all eligible cows are inseminated within a defined time window. https://extension.psu.edu/timed-ai-protocols-presynch-ovsynch
SynchED	A heifer reproductive protocol that involves some synchronization and some estrus detection. Commonly, Prostaglandin F2α (PGF, sometimes called "lut") will be given every two weeks or CIDRs (controlled internal drug release) will be inserted with PGF at removal and heifers will be found in estrus and bred.
5dCG2P 5 day CIDR synch with GnRH and 2 PGF	A heifer TAI protocol over five days, involves a controlled internal drug release (CIDR) intravaginal insert with an injection of Gonadotropin-releasing hormone (GnRH) and two injections of Prostaglandin F2α (PGF, sometimes called "lut") on consecutive days when the CIDR is removed. A GnRH injection is also given on the day of breeding. https://extension.psu.edu/using-5-day-timed-ai-protocols-on-dairies
5dCGP 5 day CIDR synch with GnRH and 1 PGF	A heifer TAI protocol over five days, involves a controlled internal drug release (CIDR) intravaginal insert with an injection of Gonadotropin-releasing hormone (GnRH) and an injection of Prostaglandin F2α (PGF) when the CIDR is removed. A GnRH injection is also given on the day of breeding.
TAIafterPD	If an animal is found to not be pregnant at pregnancy diagnosis, she will be started on a Timed AI program, such as OvSynch. Commonly, GnRH will be given the day of pregnancy check to non-pregnant animals.
TAIbeforePD	In this protocol, animals are "set up" for the OvSynch program prior to pregnancy diagnosis. Often, GnRH will be given one week prior to pregnancy check and if the animal is found not pregnant, a PGF (lut) shot will be given to continue the protocol.
PGFatPD	In this protocol, animals that are found not pregnant at pregnancy check are given a PGF (lut) shot and watched for return to estrus (heat). Sometimes this program is called "lut to breed."

Table continued on next page

BREEDING PROTOCOLS (CONT'D)	DESCRIPTION (CONT'D)
PreSynch	PreSynch includes two injections of PGF2α prior to the induction of OvSynch. PreSynch protocols increase levels of progesterone at ovulation which can help with pregnancy. https://extension.psu.edu/timed-ai-protocols-presynch-ovsynch
Double OvSynch	Double OvSynch involves a series of treatments that are essentially two OvSynch protocols in succession. The entire Double OvSynch protocol calls for two different types of hormone treatments over the span of about four weeks, with a total of at least seven times before AI. https://extension.psu.edu/timed-ai-protocols-double-ovsynch
G6G	The G6G protocol involves a single administration of PGF2α and GnRH two days later, followed by OvSynch initiated six days after GnRH. https://www.sciencedirect.com/science/article/pii/S1751731117000520
OvSynch 48	The Ovsynch 48 protocol indicates 48hrs between the last PGF (lut) injection and GnRH injection. TAI occurs 24hrs after the GnRH injection. These hourly differences can lead to different conception rates. https://www.dcrcouncil.org/wp-content/uploads/2018/12/Dairy-Cow-Protocol-Sheet-Updated-2018.pdf
OvSynch 56	The Ovsynch 56 protocol (often the most common), indicates 56 hrs between the last PGF injection and GnRH injection. TAI occurs 16hrs after the GnRH injection. These hourly differences can lead to different conception rates.
CoSynch 72	The Ovsynch 72 protocol indicates 72 hrs between the last PGF injection and GnRH injection. TAI occurs concurrently with the GnRH injection. These hourly differences can lead to different conception rates. .
5d CoSynch	The 5d CoSynch protocol indicates there are five days between the first GnRH injection and the PGF injection (instead of seven). Two PGF injections are given on consecutive days, then 48hrs later, the final GnRH injection and TAI occur concurrently.

HOUSING TYPES	DESCRIPTION
Pasture	Animals are on pasture, grazing and manure is allowed to lie as deposited.
Free Stall	Housing system for dairy cows with individual stalls where animals can lie down and with a communal area where animals can move around and access feed / water.
Tie Stall	Tie-stall systems have cows tethered to an individual stall. They are fed and usually milked in place. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/tie-stalls
Dry Lot/Open Lot	A paved or unpaved open fenced area without any crop cover. Accumulated manure may be removed periodically. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Compost Bedded Pack Barn (CBP)	Compost-bedded pack barns are an alternative to a tie-stall or free-stall livestock housing system. It is a loose housing option similar to a conventional bedded pack barn, except the pack is aerated frequently (often daily). https://www.ontario.ca/page/dairy-housing-compost-bedded-pack-barns
Deep Bedding > 1 Month	Bedding is continually added to absorb moisture over a production cycle **greater than** one month (e.g. bedded pack). https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Deep Bedding < 1 Month	Bedding is continually added to absorb moisture over a production cycle **less than** one month (e.g. bedded pack). https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf



MANURE MANAGEMENT/ HANDLING SYSTEMS	DESCRIPTION
Daily Spread	Manure is collected and land applied within 24 hours. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Solid Stack	The storage of manure, typically for a period of several months, in unconfined piles or stacks. Manure can be stacked due to the presence of bedding material or loss of moisture by evaporation. This choice should be chosen for separated manure solids that are stacked for a short period of time before use. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Composting	Biological oxidation of a solid waste including manure usually with bedding or another organic carbon source. See below for different types of composting. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Slurry Storage Underfloor	Collection and storage of manure usually with little or no added water typically below a slatted floor in a barn, usually emptied a few times a year. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Slurry with Crust	Manure stored in structures like a basin or tank, usually between 5% and 15% dry matter. There is little added water, and a natural crust is allowed to form. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Slurry without Crust	Manure stored in structures like a basin or tank, usually between 5% and 15% dry matter. There is little added water, and a natural crust is NOT allowed to form. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Covered Anaerobic Lagoon	Manure stored in structures like a basin or tank with a cover. Usually with a solids volume of less than 5%. Typically the storage found in systems where effluent from a solid-liquid separator is stored or a dairy that uses flushing to clean alleys and pens. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Uncovered Anaerobic Lagoon	Manure stored in structures like a basin or tank. Usually with a solids volume of less than 5%. Typically the storage found in systems where effluent from a solid-liquid separator is stored or a dairy that uses flushing to clean alleys and pens. Uncovered lagoons are open to the air. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Cap and Flare	Cap and flare systems involve a gas-tight plastic membrane covering the surface of manure storage structures to capture emissions and keep rainwater out. Gas collected from under the cover can be combusted in a flare to reduce greenhouse gas emissions. https://ecommons.cornell.edu/server/api/core/bitstreams/8586a845-6ed2-4c50-bab8-03b46a95d02b/content

Table continued on next page

Anaerobic Digester	Encourages the bacterial decomposition of manure in the absence of oxygen, producing biogas, which is collected and utilized. https://www.nrcs.usda.gov/sites/default/files/2022-09/Glossary.pdf
Flush	Flush systems use water to flush manure from alleyways. The water and manure are then collected and solids are usually separated with mechanical or gravity systems before the wastewater is recycled and used again. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9165779/

SOLID LIQUID SEPARATORS	DESCRIPTION
Settling Basin	Settling basins are a gravity or passive form of solid—liquid separation. Often a dairy will have several lanes to allow switching between lanes as solids take time to settle out and liquid will pass on to a lagoon.
Sand Lane/Gravity Lane	Sand/gravity lane is a separating system where a mixture of water, manure and sand flows through a lane with a slight slope. The sand hits the bottom of the lane where it can be scooped, laid out in windrows and turned to facilitate drying.
Weeping Wall	Weeping walls are a solid liquid separation system that separate through gravity rather than machinery.
Roller Press	A roller press manure separator uses a solid upper roller and a perforated lower roller to squeeze liquid out of manure solids as they exit a screen separator. This is a type of mechanical separator.
Belt Press	Belt press is a type of filter for solid liquid separation that uses two endless filter belts wound on a series of rollers with different sizes to remove water from slurry. It squeezes the slurry between filter belts and pressure. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/solid-liquid-separation
Sloped Screen	Sloped screen separators are solid liquid separators that remove solids through the flow of liquid manure as a sheet over bar slats or a wire screen. The manure passes through the slats and solids are collected and slide down the sloped separator. The liquid effluent is often pumped to secondary separations, lagoons or other storage. https://tammi.tamu.edu/files/2022/03/mp-series-screen-separator.pdf
Screw Press	Screw press solid liquid separators push manure through a tube with a group of pressure plates that control the flow. The internal pressure that is created in the tube forces the liquids through the screen and separates the liquids and solids.
Rotary Screen	Rotary screens have a wire, mesh or perforated screen which capture large fibers while allowing smaller fibers and water to drain through. The rotary design has a large screen surface area for higher efficiency in removing moisture.

COMPOSTING TYPES	DESCRIPTION
Intensive Windrow	This method involves creating long, narrow piles (windrows) that are actively managed. Composting in windrows with regular (daily, two to three times per week, or weekly depending on stage) turning for mixing and aeration.
Passive Windrow	Similar to intensive windrow composting, but less active management is involved. Composting in windrows with infrequent turning for mixing and aeration, often with installed pipes for passive aeration (no blower or other forced air).
Static Pile	Organic materials are piled in a stationary heap without regular turning. Aeration occurs naturally through the materials' porosity and sometimes through passive means, like incorporating bulking agents. It generally takes longer than other methods (several months to a year) to decompose.

NUTRIENT MANAGEMENT PLANS	DESCRIPTION
Acronyms are regulatory distinctions of nutrient management plans depending on the size of dairy and the state where it's located.	
Nutrient Management Plan (NMP)	NMPs are the most common; generally applicable to most size dairies above a certain threshold.
Comprehensive Nutrient Management Plan (CNMP)	Generally, a CNMP applies to CAFOs—though some smaller farms need one depending on how they handle manure.
Manure Management Plan (MMP)	MMPs vary—some states have them for smaller dairies, though not necessarily required by regulation.

NUTRIENT APPLICATION	DESCRIPTION
Injection	Manure injection is the practice of placing manure directly beneath the soil surface during application. The types of injection setups include: • Knife injection • Chisel/sweep injection • Discs or coulters
Broadcast	Process of spreading manure or fertilizer on the surface of the soil often with a manure spreader or fertilizer sprayer.
Sidedress	Nutrient sidedressing involves applying fertilizer partway through the growing season, most commonly nitrogen on corn.
Dragline	Draglining is a method of applying liquid manure over large areas using a system of hoses and pipes. The process involves pumping manure through a network of hoses to the field. The manure is either spread on the surface or injected into the soil using specialized equipment.
In Furrow	Fertilizer application occurring at the time of planting, often in the same furrow as the seed or nearby (2 x 2 is a common method).



TILLAGE TYPES	DESCRIPTION
Subsoiler	Subsoilers cut and loosen soil below the normal tillage depth. It is designed to loosen a greater volume of soil with only a small increase in required pulling force. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/subsoiler
Moldboard Plow	Moldboard plows cut soil, lift and turn it upside down to loosen soil that has been compacted. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/moldboard-plows
Coulter Chisel Plow	Coulter chisel plow is a modified chisel plow that can help with minimum tillage in all residue conditions. The coulters help cut heavy residues (ex. corn stalks), helping retain 30–75% of residues on the surface after a single pass. https://soilmanagement.ces.ncsu.edu/tillage-management/chisel-plow/
Seedbed Conditioner	A secondary tillage implement to prepare seedbeds. Typically used to smooth and firm the soil for planting. https://efotg.sc.egov.usda.gov/references/public/ME/tillage_implements.pdf
Disk Harrow	Disk harrows consist of concave metal disks with either a smooth or scalloped edge. They are used for smoothing the plowed soil surface to prepare for planting. https://soilmanagement.ces.ncsu.edu/tillage-management/disk-tillage/



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Beef on Dairy

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The rapid growth of beef semen use in dairy herds has created beef from dairy supply chains. Beef-dairy crossbreds in the feedlot have progressed rapidly since 2018 in the U.S. *Photo by Michelle Kunjappu, PA Beef Producers Working Group.*

Meat quality of beef-dairy crosses

While creating beef from dairy supply chains is not a new concept, discussing optimal beef genetics for Holstein cows is a recent and critical need. The rapid growth of beef semen

use in dairy herds has added value to beef-dairy progeny, but meat quality consistency is needed.

Tara L. Felix (/authors/4342-tara-l-felix) and Bailey Basiel (/authors/6932-bailey-basiel)
January 17, 2024

Creating beef from dairy supply chains is not a new concept. For the past seven years, Penn State research programs have emphasized dairy progeny as part of the beef supply chain. And due to their tight genetic makeup, consistency of product from purebred dairy cattle, particularly Holsteins, made them a known commodity for the beef industry.

Discussing optimal beef genetics for Holstein cows is a recent and critical need. The use of beef semen to breed Holstein cows has risen sharply in the U.S. Domestic beef semen sales have skyrocketed by over 350% since 2017.

Consistency is needed

The rapid growth of beef semen use in dairy herds has added value to beef-dairy progeny, but packer complaints about the inconsistency of beef-dairy carcasses came early and often in those first few years of beef-dairy production. This is logical because the commodity beef industry has product specifications, or “a box” for native beef cattle and “a box” for fed Holstein cattle (mostly steers) that are well established and meet specific customer demands and expectations. These boxes allow the industry to package beef effectively and efficiently for cold transportation around the globe. However, beef-dairy crossbreds were not fitting in either box.

The challenges facing the packer during the early rise of beef-dairy “boom” were real-world issues that required rapid solutions because these crossbred progeny were (are) being generated specifically for terminal markets.

Europe data, which predates U.S. data on beef-dairy crossbreds by several decades, have suggested that the meat from crossbred calves was more valuable than the meat from purebred dairy cattle and that crossbred calves from late-maturing breed types (Charolais, Limousin and Simmental) had better average daily gain and carcass characteristics than their counterparts from early maturing breeds. European markets routinely employ the use of beef breeds known for heavy muscling (Belgian Blue, Limousin and Galacian Blonde) in their Holstein cows to increase meat yield. While compelling for the European marketplace, the beef breeds selected in these previous research studies are known in the U.S. for poor carcass quality – i.e., not producing tender beef and not marbling well, little fat deposited in the muscle. In a market that lauds tender, USDA Choice and Prime, poor carcass quality just won’t cut it.

Research on beef-dairy crossbreds in the U.S. has progressed rapidly since 2018, in part due to necessity. Data from Texas Tech University (TTU) would suggest that the quality of beef-dairy carcasses rivals that of native beef cattle. In their studies, researchers report that carcasses from beef-dairy cattle are able to achieve similar quality grades at reduced yield grades.

Most cattle in the U.S. are marketing on a quality and yield grid. The grid systems ranks quality, from least to greatest, as Select, Choice (low, average or high) or Prime while assigning yield, from most to least desirable, on a numeric scale of YG1 to YG5. Payouts to the customer in a grid marketing system are greatest for cattle with the greatest quality and the most desirable yield (Prime, YG1, for example). Therefore, the TTU data suggests that beef-dairy carcasses may achieve premiums for Choice and Prime while avoiding the hefty discounts that come with Yield Grade 4 and 5 carcasses.

The consumer's part

In addition to the packer's willingness to pay for product, the consumer's willingness to eat the product drives value. In the previous case of the European beef breeds being used, for example, the U.S. customer would be more willing to reject tough, poorly marbled steaks that those heavier-muscled genetics may supply.

However, the TTU data reports nearly all of the steaks from beef-dairy crossbreds qualified as USDA Certified Tender. Similar observations related to tenderness were made on ribeye steaks from beef-Jersey cattle by Ohio State researchers. On average, the steaks evaluated at Ohio State qualified as USDA Certified Very Tender.

The sire

Perhaps what is still not discussed enough in the beef-dairy conversation is that sire selection matters. Unpublished data from our research group suggests that sire breed and genetic merit impact the tenderness and marbling of beef-dairy carcasses.

Over the course of a three-year investigation, ribeye steaks from Angus-Holstein steers were more tender than those from beef-Holstein steers sired by Charolais, Hereford, Limousin or Simmental bulls. On average, the ribeye steaks from beef-Holstein steers from all sire breeds, except Simmental, qualified for USDA Certified Tender, and those steaks from steers sired by Angus, Hereford and Limousin bulls qualified for USDA Certified Very Tender.

Measured intramuscular fat (IMF) was greatest in ribeye steaks from Angus-Holstein steers, while steaks from Charolais-Holstein, Limousin-Holstein and Simmental-Holstein steers had the least IMF.

Before we get hate mail from all the breed associations, it is critically important here to note that it is not just the breed of the beef sire that matters but the individual sire themselves. Any cow-calf producer interested in improving genetics carefully studies sire expected progeny differences (EPDs) before selecting the individual sire to use in a given year.

But in the feedlot, we have routinely discussed cattle in two ways: by origin (Mexican or U.S.) and by hide color. The 2022 NBQA reported that only 12% of fed cattle had Holstein-colored hides, down from 20% in 2016. No doubt, this shift was in response to the estimated 2.2 million beef-dairy calves in 2022, just under 10% of the annual fed cattle supply. That variation in sire genetics means that not all beef-dairy cattle are created equal, regardless of breed.

Sire EPDs for terminal traits should be carefully considered when selecting bulls to use in beef-dairy mating programs. A shining example of why selection matters comes from University of Arizona researchers. In 2023, Waller and colleagues reported that selecting Limousin sires that have a mutation in a single gene, myostatin, can reduce steak angularity, a common challenge with dairy-influenced genetics, without impacting other consumer acceptance parameters. The Arizona researchers observed that beef-dairy progeny that inherit a copy of the mutated myostatin gene from their sires did not have reduced tenderness.

Perhaps the biggest question that still surrounds beef-dairy production is the economic viability of the system. Valuation of beef-dairy progeny has been poorly quantified throughout the supply chain, in part due to the multiple changes in ownership throughout the life of the animal. Current markets in the Northeast value day-old beef-dairy cattle at up to $700. These markets are likely not sustainable, regardless of how good the meat may be. Prices will likely stabilize when (or if) the beef cow herd begins rebuilding. In the meantime, as dairy farmers continue to supply a portion of the nation's fed beef supply, choosing the right sires to use for terminal beef-dairy matings will be important in maintaining consistent, high-quality desirable beef.

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Penn State's recent study found that beef-on-dairy calves meet the standards that both the dairy and beef industries require. *Photo courtesy of Penn State.*

Beef-on-dairy research from Penn State: Supply must match demand

Research suggests breeding dairy cows to beef semen is a sound investment for dairy operations and that these cattle are meeting beef industry requirements.

Tara L. Felix (/authors/4342-tara-l-felix)

November 11, 2024

Dairy farms across the U.S. have been breeding a portion of their cows to beef sires since 2018. As a result, domestic beef semen sales grew by nearly 7 million straws from 2017 to 2023. The resultant crossbred progeny, known as beef-on-dairy, has provided challenges and opportunities for both the beef and dairy industries. Penn State collected data over four years to evaluate the impact of beef-on-dairy progeny on these industries.

The dairy industry

One of the first questions surrounding the beef-on-dairy matings was: Would mating dairy cows to beef sires impact relevant dairy outcomes? While the calf is a necessary outcome for milk production, it is well-established that difficult deliveries can reduce productivity in subsequent lactations and, potentially, cow longevity. One of our goals was to assess the impact of beef sires on dairy cow productivity and health postparturition. Over 75,000 records from cows across 10 dairy herds from the Northeast and Midwest were **summarized** (https://doi.org/10.3168/jds.2023-24112).

Results suggest that beef-on-dairy matings resulted in altered gestation lengths. In multiparous cows that carried beef-sired calves, gestation length was increased when compared to cows that carried Holstein-sired calves. Limousin-sired and Wagyu-sired impacted gestation length the most. Cows that carried Limousin-sired and Wagyu-sired calves carried them for five and eight days longer, respectively, than those that carried Holstein-sired calves. These data suggest that dairy farms using Limousin and Wagyu semen should consider extending the dry-off dates of cows mated to Limousin and Waygu sires to allow for an additional week of milk production from those cows.

Additional analyses of the records suggest that the incidence of dystocia, postpartum health events and early culling decisions were not impacted by sire breed. In addition, dairy cows mated to beef sires suffered no production losses in the lactation following delivery of a beef-on-dairy calf.

Current economics demonstrate that beef-on-dairy progeny are worth several hundred dollars more per head to the dairy as young calves at auction than their purebred dairy counterparts. Thus, the lack of impact on dairy productivity and the increased economic return to the dairy indicate that beef-on-dairy matings are a sound investment for the dairy industry.

The beef industry

Once beef-on-dairy was noted as a sound investment for the dairy, the logical follow-up question was: How do beef-on-dairy progeny impact the beef supply chain? The commodity beef supply chain dictates that fed cattle fit a narrow range of standard parameters, referred to as fitting the box. The standards are based on consumer expectations such as loin size

because meat cuts from fed cattle are literally boxed and shipped nationally and internationally. At the start of the rise of beef-on-dairy, beef producers were left with a mishmash of genetics and unpredictable growth and carcass performance – all based on mating decisions made at the dairies. Since then, many breed associations and semen companies have begun to publish bull recommendations for dairy producers, and the industry is well past simply breeding dairy cows to cheap black semen.

The **research** (https://doi.org/10.1093/tas/txae043) conducted by Penn State evaluated three years of phenotypes for feedlot growth performance and carcass characteristics of beef-Holstein steers. Progeny were sired by seven different beef breeds including Angus, Charolais, Limousin, Hereford, Red Angus, Simmental and Wagyu. Sires within breeds were chosen based on their rankings as terminal sires (sires that would add growth and good amounts of muscle) at the time of mating when such rankings were available. Thus, beef sires were not solely selected for hide color or the price of the semen, but intentionally selected as sires that would make beef.

Two major criteria drive the economics of the beef cattle industry: 1) how efficiently cattle can grow – namely muscle – and 2) how well they can marble, or deposit fat, in their muscle tissue. When summarized across all three years of data, there were no differences in feed efficiency, measured as gain to feed, among cattle regardless of sire breed. However, Angus-, Charolais-, and Simmental-sired beef-Holstein steers had the greatest average daily gain (ADG) and, thus, spent the fewest days on feed. Wagyu-Holstein spent five to 26 more days on feed than any other breed. This alteration in days on feed can have a large impact on the industry. Fewer days on feed means cattle feeders can bring younger, more efficient cattle in quicker and, thus, reduce the annual overhead costs of the operation by spreading those costs over more cattle.

In addition, the growth of these cattle resulted in similar muscling across breeds. The industry uses dressing percentage – the pounds of carcass weight divided by the pounds of live weight – as one estimate of muscle in cattle because it drives the amount of saleable red meat yield from the carcass. Most beef breeds will have an average dressing percentage of 63% to 64%, whereas purebred Holsteins have always been challenged in this area and struggle to reach 60%. Across all breeds in the Penn State study, beef-on-dairy cattle had average dressing percentages of just over 61%, suggesting they have a greater propensity to muscle than purebred dairy counterparts.

The second economic driver of the industry is the quality of the meat, measured as marbling and reported/sold, based on the USDA Quality Grade, coming from the carcasses of those fed cattle. Currently, approximately 85% of the fed cattle in the U.S. grade USDA Choice or better, creating a certain industry expectation for carcasses that will marble well. Carcasses from Angus-, Charolais-, Hereford-, Red Angus- and Wagyu-sired steers marbled similarly,

and all averaged a USDA Choice quality grade. Although carcasses from Limousin- and Simmental-sired steers did not marble as well as carcasses from the aforementioned breeds, the majority of those carcasses from Limousin- and Simmental-sired steers still graded USDA Choice on average.

Taken together, these data suggest then that beef-on-dairy progeny, whose sires are selected based on key terminal characteristics such as muscling and marbling, meet the current beef industry expectations.

How we move forward

The terminal selection criteria that the study used make use of sire expected progeny differences (EPDs). Most dairies are well-versed in using predicted transmitting abilities (PTAs) to choose a sire that will produce a heifer that will be profitable for the dairy. Dairies will need to become more comfortable selecting beef sires based on their genetic value to the beef industry to maintain a solid beef-on-dairy market.

The data generated from Penn State would suggest that beef-on-dairy cattle will have a greater potential to put on muscle than purebred Holstein steers if bull selection was appropriate, and because the beef cattle industry is focused on saleable red meat yield, there appears to be potential in the beef-on-dairy calves. However, the price paid for those calves and the costs to reach 500 pounds will be determining factors in the longevity of these breeding programs.

Cattle economics vary daily, and the market shifts can be unpredictable. Beef-on-dairy calves can work in the beef supply chain, but current supply and demand economics are driving record-high prices for calves. There will come a time, eventually, when the beef cattle supply, currently at a historic record low, will rebound, shifting the demand for beef-on-dairy calves and driving down the price. Therefore, dairies will have to work harder in the future to provide calves that can grow and perform in a beef market when that demand shifts.

References omitted but are available upon request by sending an ***email*** (mailto:editor@progressivedairy.com) *to the editor.*

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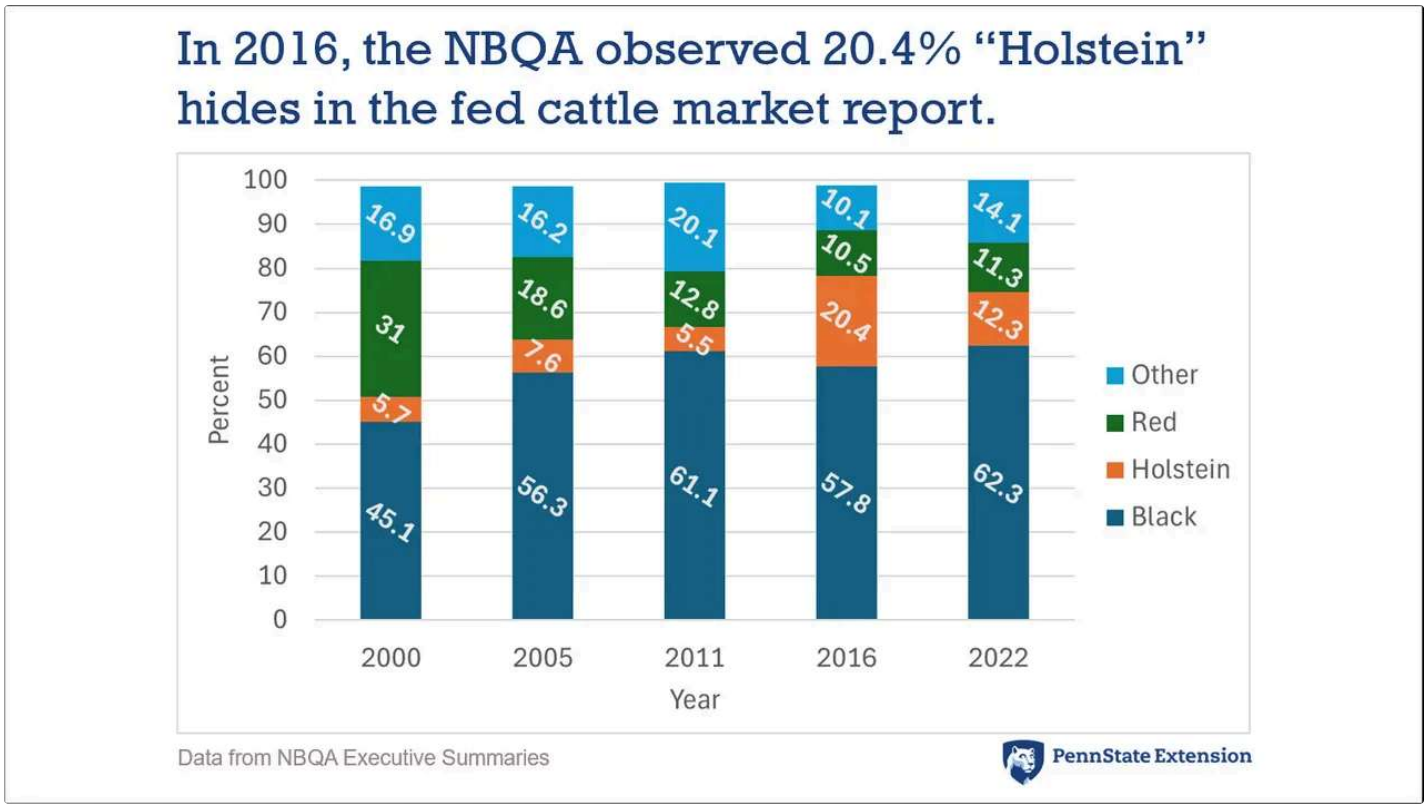
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Clint Peck

July 7, 2026

7 Min Read



National Beef Quality Audit

At a Glance

- The dairy industry historically considered its bull calves a costly nuisance.
- The breakthrough in beef-on-dairy came through gender-sorted semen.
- Fed beef that comes from the dairy side has fluctuated around 20% for about 30 years.

Dairy farmers long considered bull calves a nuisance. The best they could hope for was to sell them into the veal market. But the market for veal has always been sketchy and localized. The worst case for dairy-bred bull calves was going directly to the dead pile.

For decades, there have been moderate- to large-scale efforts by specialized cattle feeders to take those pesky dairy steers and make beef out them. They proved Holsteins calves could transition after weaning immediately to high-energy, grain-based finisher rations. One payoff was the tight genetics of the Holstein breed, which made feedlot performance and processing traits inherently consistent.

Even with the successes seen in feeding Holstein steers, innate challenges remained in meeting the potential of the dairy-beef sector. Dairy steers tended to fall short compared to their beef counterparts in the critical measures of feed conversion and average daily gain.

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Holstein beef carcasses couldn't stand up to the beef breeds — particularly in dressing percent, red meat yield and the critical ability to produce a high ratio of Choice and Prime carcasses. Liver abscesses and overweight carcasses also dogged the Holstein calf-fed model.

Dark days for dairies

Meanwhile, dairy farmers nationwide have historically been plagued by economic ups and downs in selling fluid milk through a myriad of complex price-setting structures. Declining consumption and aggressive competition from milk substitutes hit the industry double-hard in the 2010s.

To make matters worse, in 2016 and 2017, the value of Holstein bull calves plummeted. With increasing feed grain costs and tight feedlot margins calves that earlier had fetched $500 per head plunged to less than $100 per head — bordering on worthless.

"Our dairy industry was in trouble," said Tara Felix, Penn State University beef cattle Extension specialist. "A lot of dairies were going out of business, co-ops were closing and there were some pretty scary projections of what a dairy in Pennsylvania might look like in the future."

Felix's Calf-fed Holsteins Reared for Beef Demonstration Project proved to the Commonwealth's dairy producers that utilizing calves generated by their dairies could be the difference between insolvency and hanging on for many farmers.

"We have more than 500,000 dairy cows in the state," Felix added. "Each one of those cows has a calf every year to keep milk production going. Some of those become replacement heifers, but the rest are capable of producing high-quality beef. We knew we needed to take advantage of that."

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The breakthrough

The industry-wide breakthrough came with the availability of gender-sorted semen, although it took a while. The first gender-selected calf using frozen semen was born in 1999, with commercial distribution in the U.S. beginning around 2004.

Early sperm sorting practices resulted in high cell mortality, with high costs and limited availability of quality semen. Refinements in semen sorting procedures have since proved less damaging to sperm cells. By 2015, conception rates with sexed semen were closely approaching those of conventional semen.

Diary producers could now use female sexed dairy-type semen on their top cows to generate replacement heifers. Male beef-type sexed semen could be used on the remainder of the herd to produce beef-cross bull calves.

It didn't take long for the dairy business to embrace gender-sorted semen.

From 2017 to 2018, beef semen sales to dairy herds jumped from 2.5 million units to just over 4 million units. By 2023, 7.9 million units of beef semen were sold to dairy farmers, a nearly 1 million-unit increase over the previous year. For 2025, the National Association of Animal Breeders reported "gender selected" beef semen sold to dairy farmers reached 8.1 million units.

Related: July/August 2026 edition of BEEF available

A 2024 survey completed by Purina found that among surveyed dairy producers, 72% are actively implementing crossbreeding programs — while another 16% indicated they are considering crossbreeding. Another 6% said they had tried crossbreeding but are not currently participating, and 6% expressed no interest in adopting the practice.

Purina also reported that 80% of dairy farmers and 58% of calf raisers received a premium for beef-on-dairy calves compared to purebred Holstein calves — reaching $700 per head. More recent sale barn reports show those premiums are approaching $1,000 per head today.

Timing is everything

It all couldn't come at a better time for satiating the historic global demand for high-quality beef.

Felix found that crossbred beef-on-dairy steers yielded 28 pounds more hot carcass weight than their straightbred Holstein counterparts. They also had with significantly larger ribeye areas (2 square inches) and finished with 74% USDA Choice versus the purebred Holsteins at 25% Choice.

The Livestock Marketing Information Center in 2024 suggested a 0.5% gain in beef produced from beef-on-dairy carcasses compared to Holstein carcasses. So, while there's only a slight increase in beef production, the practice results in a significant increase in carcass quality.

And it takes a look back at the history of those "excess" dairy bull/steer calves and making beef out of them to get a glance into the future of beef on dairy.

Cattle slaughter data from the late 1990s to the early 2000s show dairy-type cattle (primarily straight-bred Holsteins) comprised 5-6% of the nation's total fed beef supply.

In 2005, the National Beef Quality Audit (NQBA) showed Holsteins accounted for 7.6% of fed cattle, which dropped to 5.5% in the in 2011 audit (see chart). The lift came in 2016, when 20.4% of the fed cattle supply was reported to be from purebred Holsteins. Note that this was before the beef-on-dairy boom.

After 2016, the influence of the beef-on-dairy began showing up in the fed cattle mix. By 2022 Holstein-hided cattle had dropped to 12.3% of the fed cattle supply. Correspondingly, there was an increase in cattle from both the "black" hide group (+6.5%) and "other" (+4.0%) hide color categories.

"What we're seeing in this audit data is not necessarily a shift away from feeding dairy progeny," Felix explained. "It simply corroborates the uptick we've seen in the production of beef-on-dairy calves."

Beef-on-dairy simply replaced a large portion of the straightbred dairy steers on feed.

Pushbacks and payoffs

Over the past 20 years, total U.S. dairy cow numbers have remained relatively stable — hovering around 9.5 million head. And Felix said there's nothing on the horizon to suggest the nation's dairy herd is going to change appreciably.

Felix said she still gets pushback from cow/calf producers saying she's trying to put them out of business. The reality is that not much has changed: The proportion of U.S. fed beef that comes from the dairy side has always fluctuated around 20%.

"I hear all the time that 'my' beef-on-dairy genetics are replacing beef genetics," Felix said. "I tell those guys that we've simply made dairy genetics a little bit better by putting good beef sires on top of them. Beef-on-dairy is here to stay — let's be clear about that."

There are signs the practice of beef-on-dairy is reaching its maturation, and its impacts are probably already baked into today's beef supply chain. Some tweaking will occur within beef-on-dairy production — namely addressing lingering liver abscess issues and carcass size. And there will inevitably be system-wide integration.

As dairy-origin crossbreds become essential to U.S. beef supply, they're reshaping cattle production and potentially providing better price and supply stability to both markets, said Daniel Munch, economist for the American Farm Bureau Federation.

The payoff to U.S. agriculture is that beef-on-dairy now represents a fundamental change in risk management for dairy farms — as well as bringing more high-quality U.S. beef to the meat case.

"Instead of being fully exposed to the volatility of the milk market, dairy producers now have an alternative revenue stream through beef-on-dairy crossbreeding," Munch explained. "This dynamic could help stabilize milk markets by naturally curbing oversupply during periods of high prices, creating a more balanced production cycle."

"At the end of the day, it's about feeding people," Felix concluded. "The evolution of beef-on-dairy is something to be proud of and can also benefit the cow/calf industry to improve sustainability for the entire beef supply chain."

About the Author



Clint Peck

Peck, a fourth-generation Montanan, was born on a small farm east of Billings and raised in the Yellowstone Valley. Peck graduated from Montana State University in 1978 with a degree in agricultural production and went directly to work as foreman on a cattle ranch in west-central Montana....

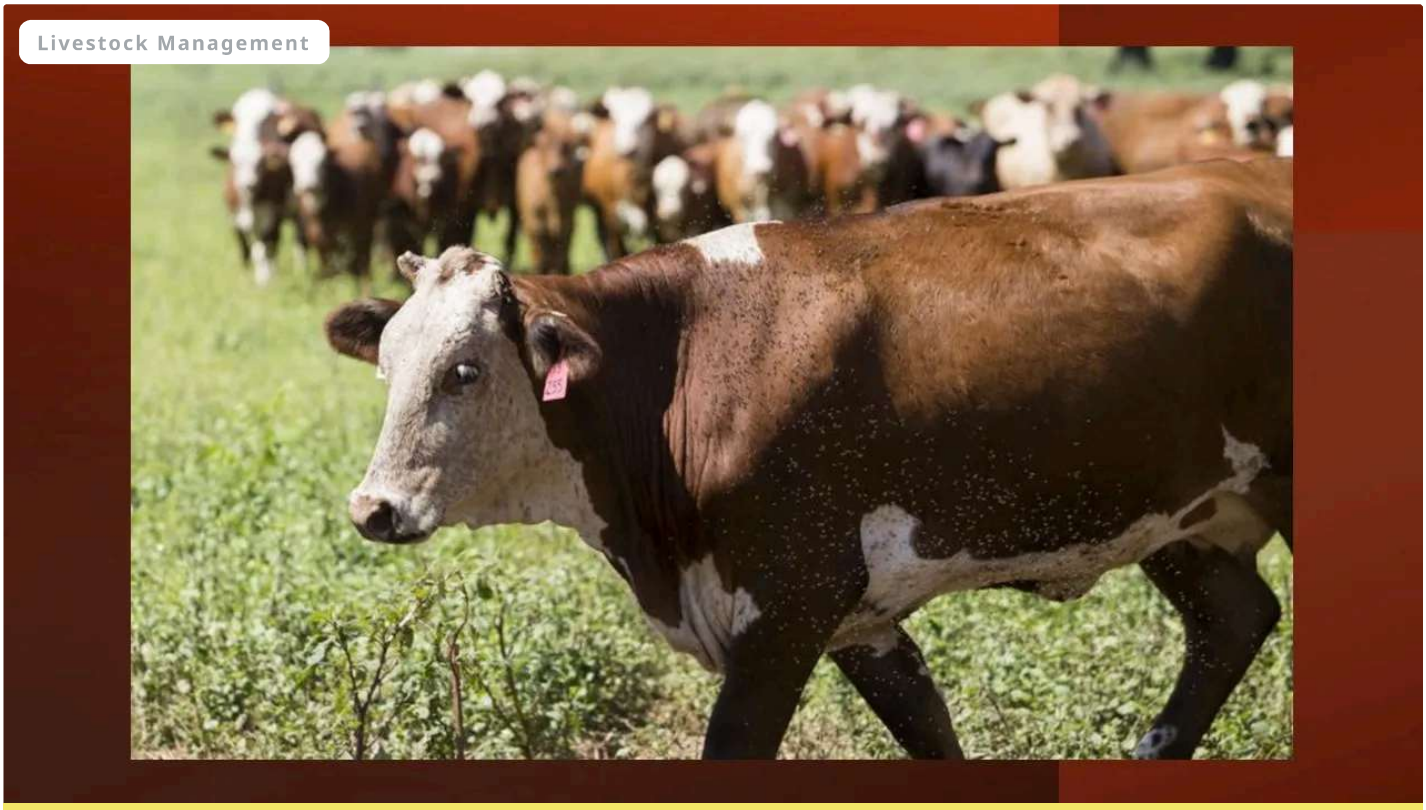
You May Also Like



Monitoring water sources to protect herd health

by **Kansas State University**

Jun 18, 2026



University of Florida receives $9.5M gift to address cattle pest threats

by **University of Florida IFAS**

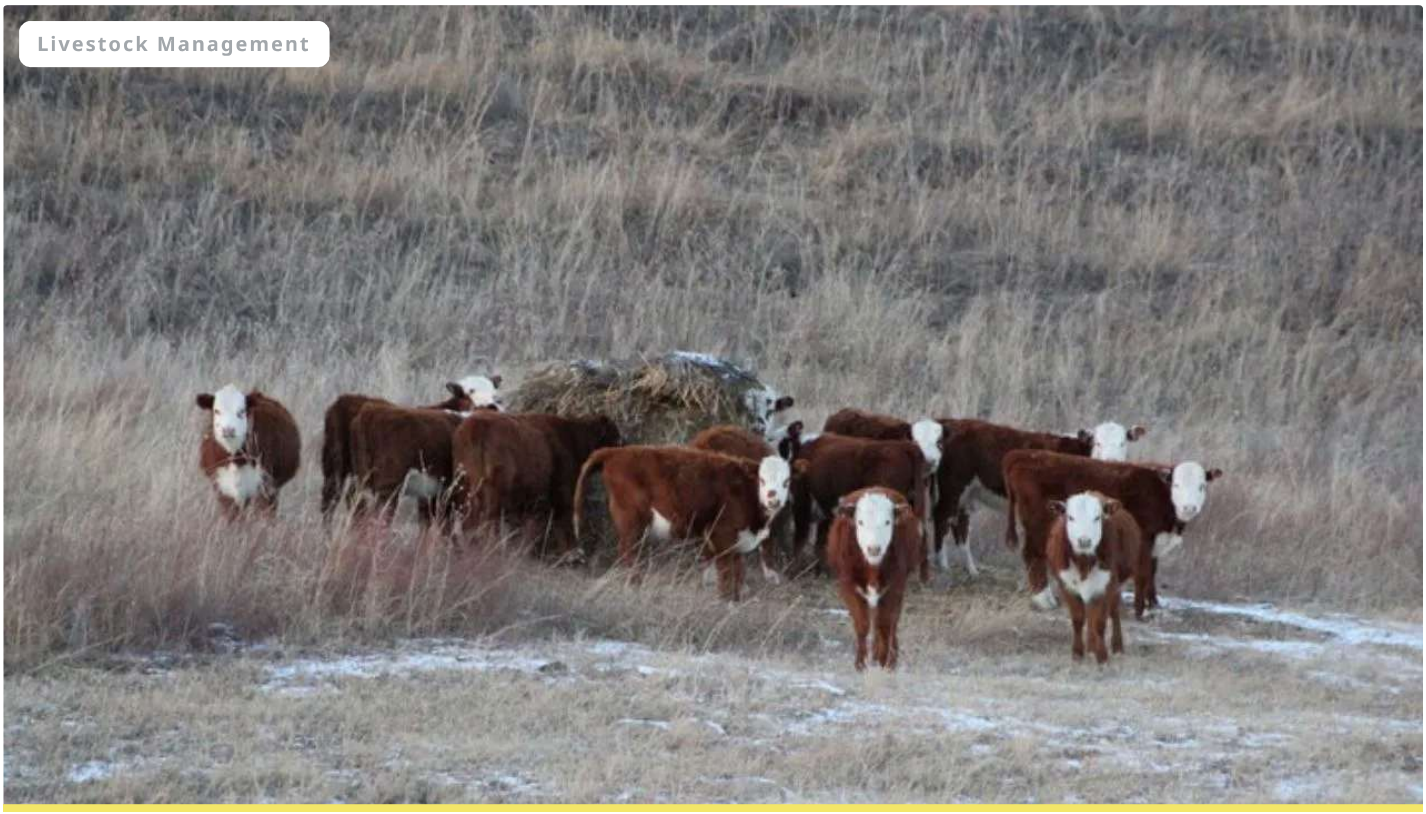
Jun 12, 2026



BCS at calving a key predictor of reproductive success

by **The Ohio State University**

May 14, 2026



Does bale grazing make sense?

by **University of Nebraska-Lincoln**

Nov 05, 2025

Source: https://www.beefmagazine.com/livestock-management/sorting-out-the-rapidly-maturing-beef-on-dairy-revolution

Reproduction and Sire Selection

The Importance of Sound Reproduction in your Dairy Herd

Ryan Allen | Premier Select Cooperative
rallen@premierselect.com | Key Account Specialist

Agenda


Introduction
Why does Repro matter?
5 keys to Strong Repro
Timed AI Programs
Preg Checking + Troubleshoot

My Background

- Raised on family dairy farm
- Penn State for Education
- Herd Manager in Vermont
- Premier Select Sires









Premier Select Sires

- Cooperative. By farmers; For Farmers
- Industry Leader in Genetics
- Premier: Local Representative
- Want our products, and owners to reach their fullest potential
- Value Added Services
  - Repro Services, Analysis, Advising

SELECT SIRES INC.

RSS

SMS SELECT MATING SERVICE

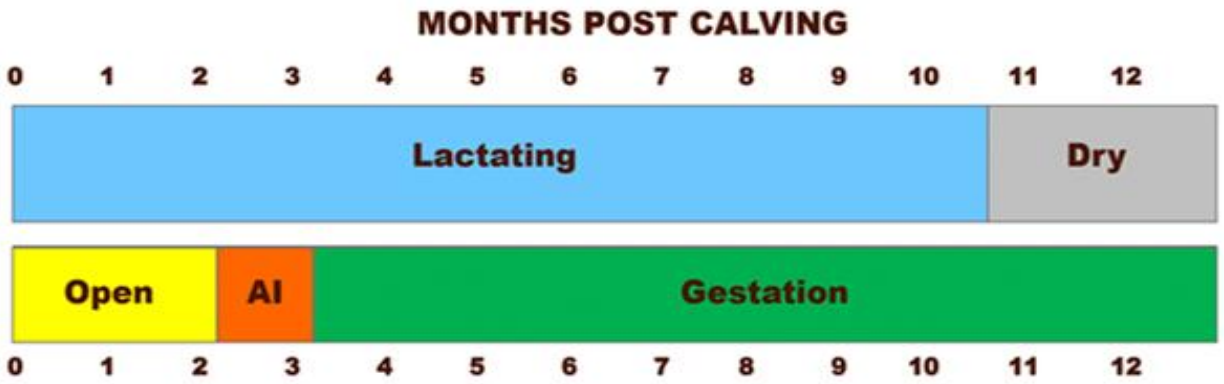
Select Reproductive Solutions

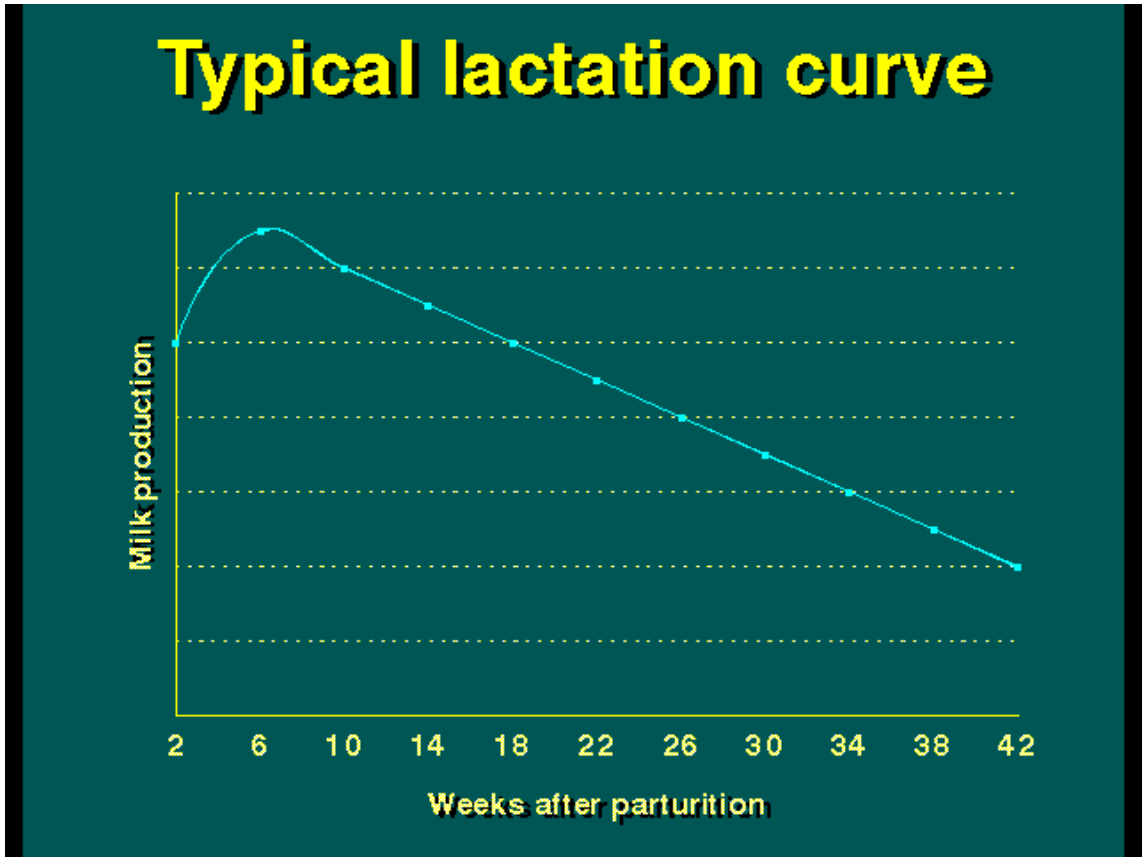
PREMIER SELECT COOPERATIVE YOUR SUCCESS Our Passion.

Why does Reproduction matter?

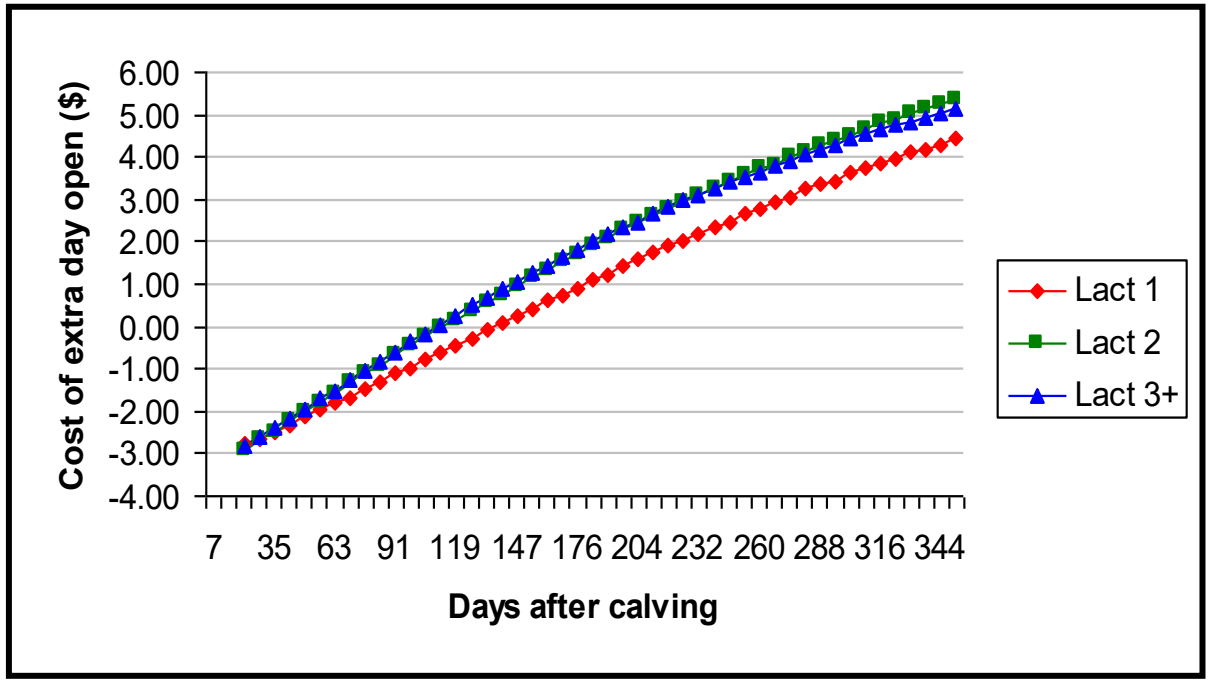
Importance of Repro – Getting Them Back to Peak

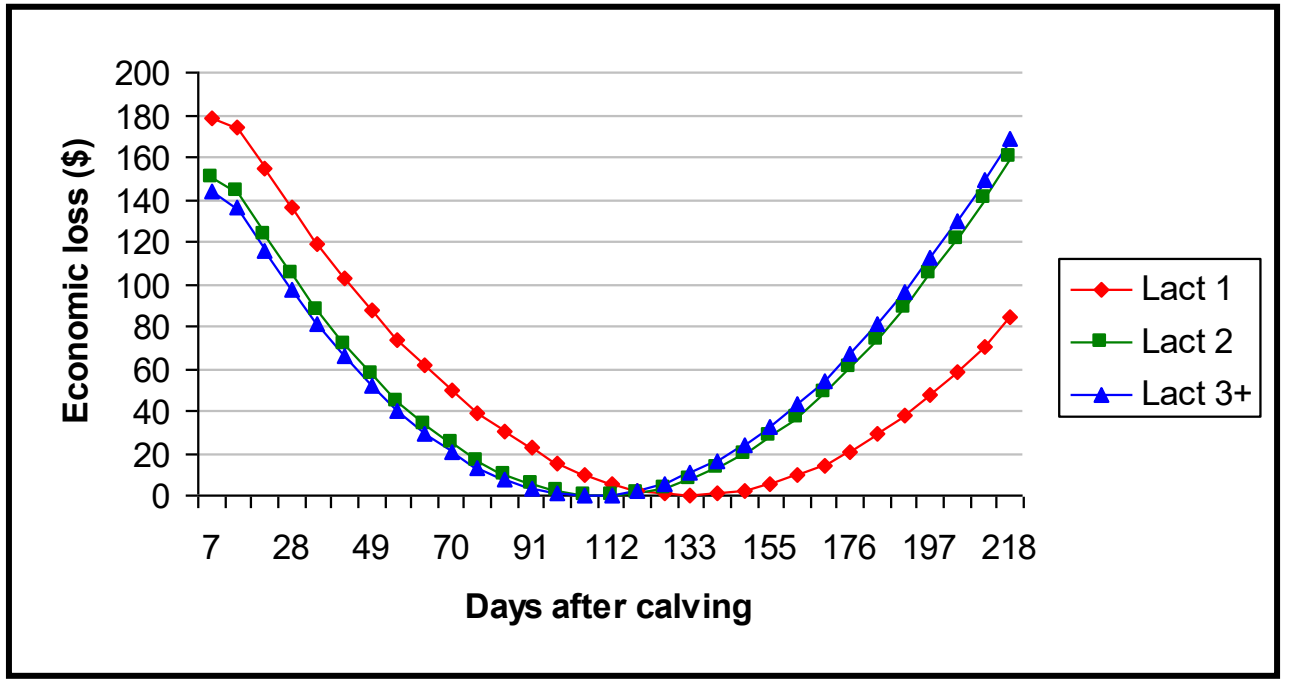
- Nothing happens if they stay heifers forever!
- The ability to quickly get an animal back into calf is critical
- Ability to improve profitability of animals through genetic



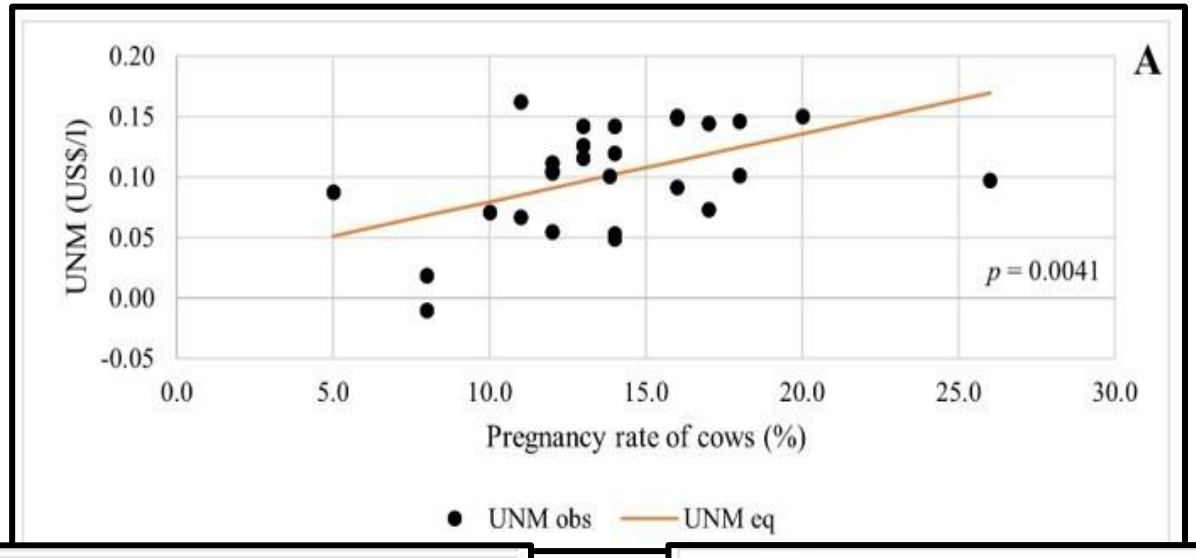


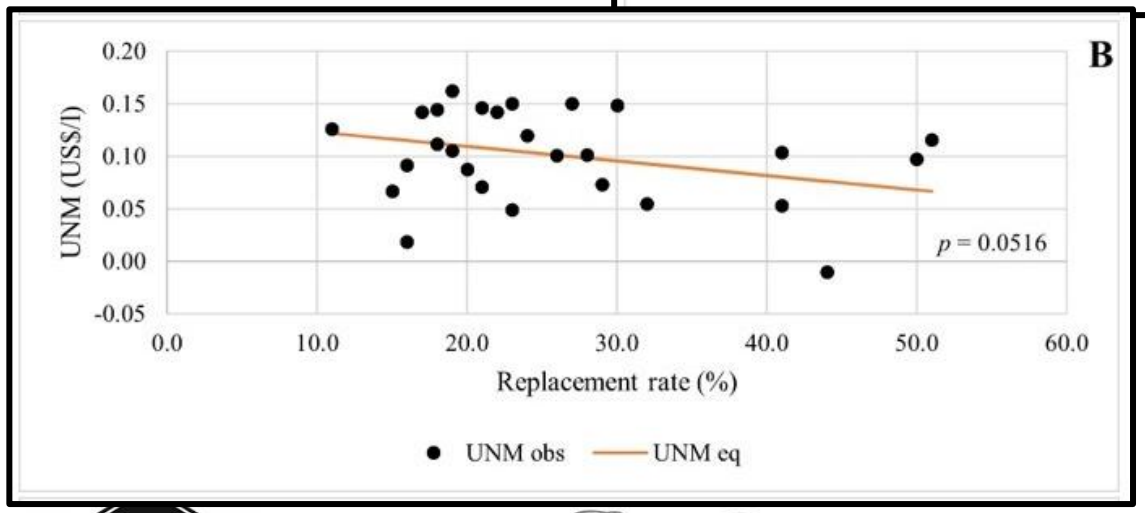
Good Repro Pays – (DeVries Research UFL)

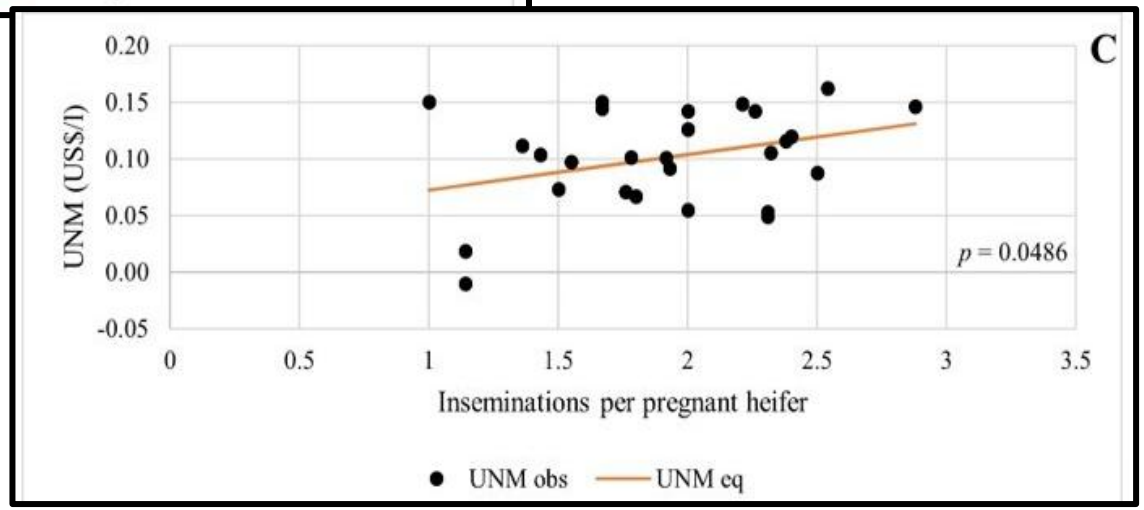




Good Repro Pays – (Santos research at SENAR)







Good Repro Pays In Lancaster County

1. Getting them back to peak milk
2. Calf Value
3. Cost of raising heifers
4. Genetic Progress
5. Return of Semen Cost

Benefits of AI

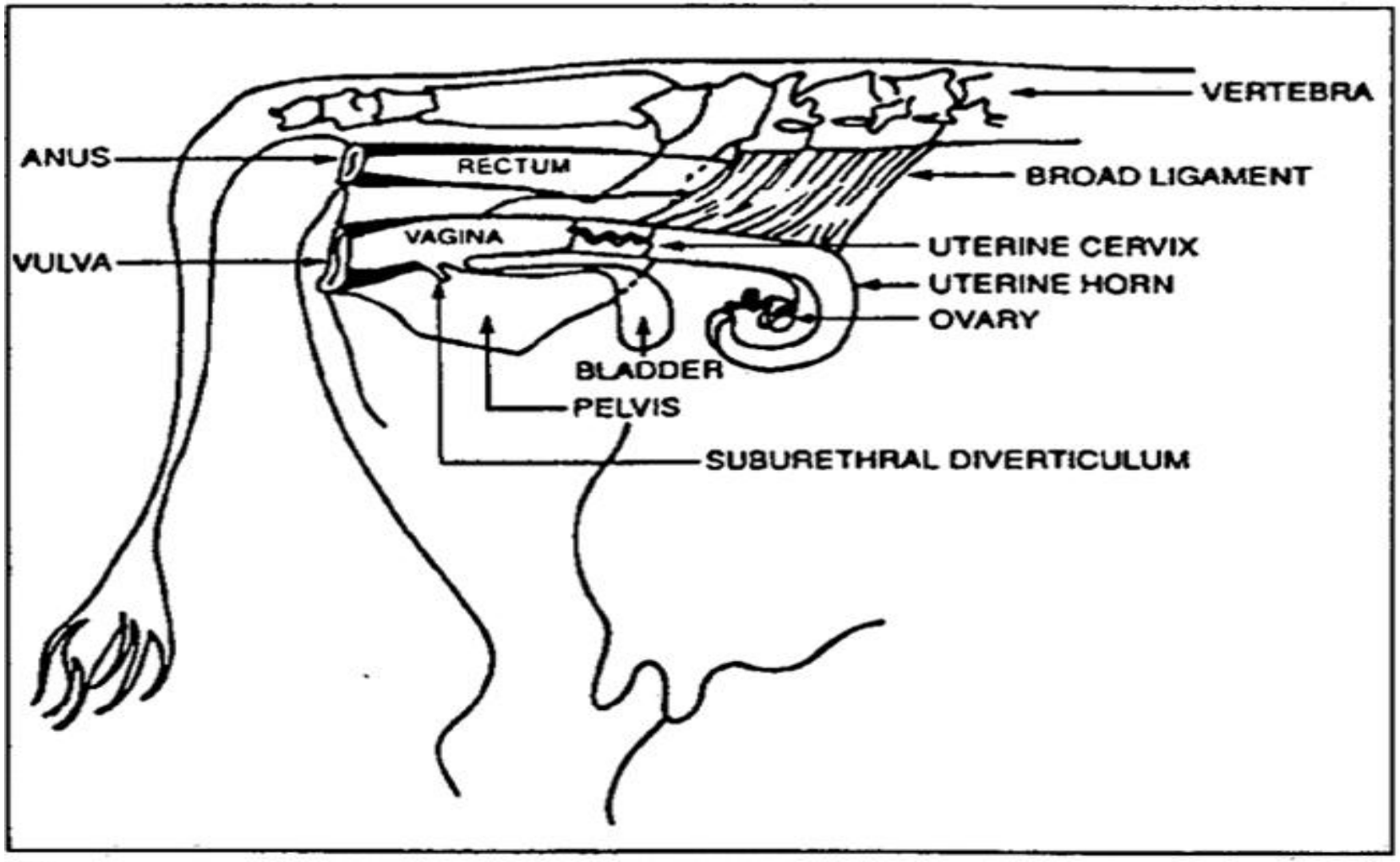
Access to superior genetics!!

- Improved Reproductive Health
  - Tool for Crossbreeding
- Improved conception rates
- Reduced bull requirements

FIGURE 1

$$\text{GENETIC PROGRESS} = \frac{\text{Selection intensity x Accuracy x Variation}}{\text{Generation interval}}$$

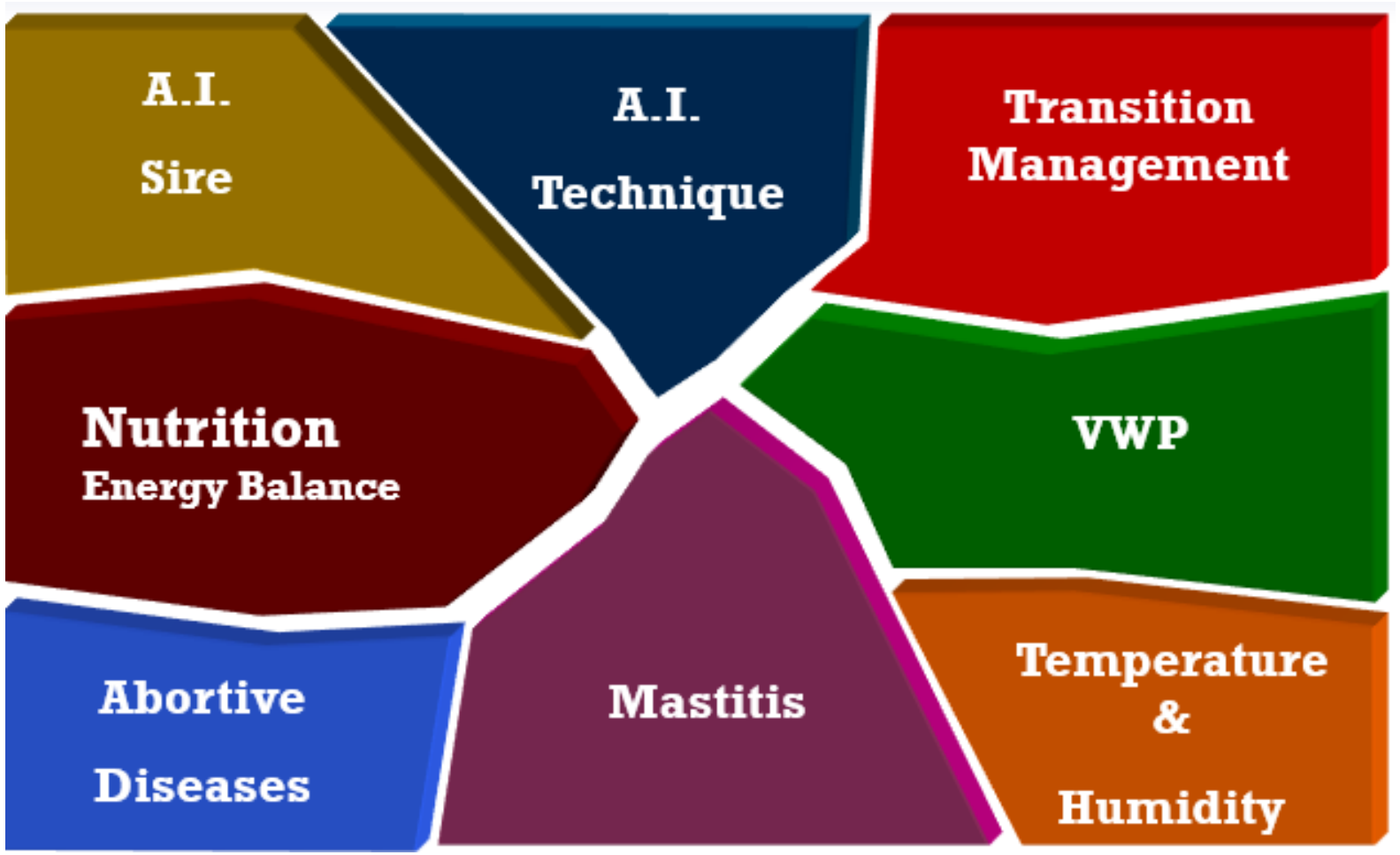
How to Breed a Cow



Reproduction Benchmarks

Metric	Great	Average	Opportunity
Days to First Service	80	60 or 100	Over 100
% Bred by 100 DIM	100%	85%	Under 75%
Lact 1 Conc %	50%	45%	35%
Lact 2+ Conc %	45%	35%	30%
Heifer Conc %	65%	45%	40%
% Preg by 150 DIM	80%	65%	50%
Heat Detection Rate %	75%	65%	50%
Preg Rate	35%	27%	20%
Palpation Rate @ Preg Check	70%	60%	50%

Factors affecting a pregnancy

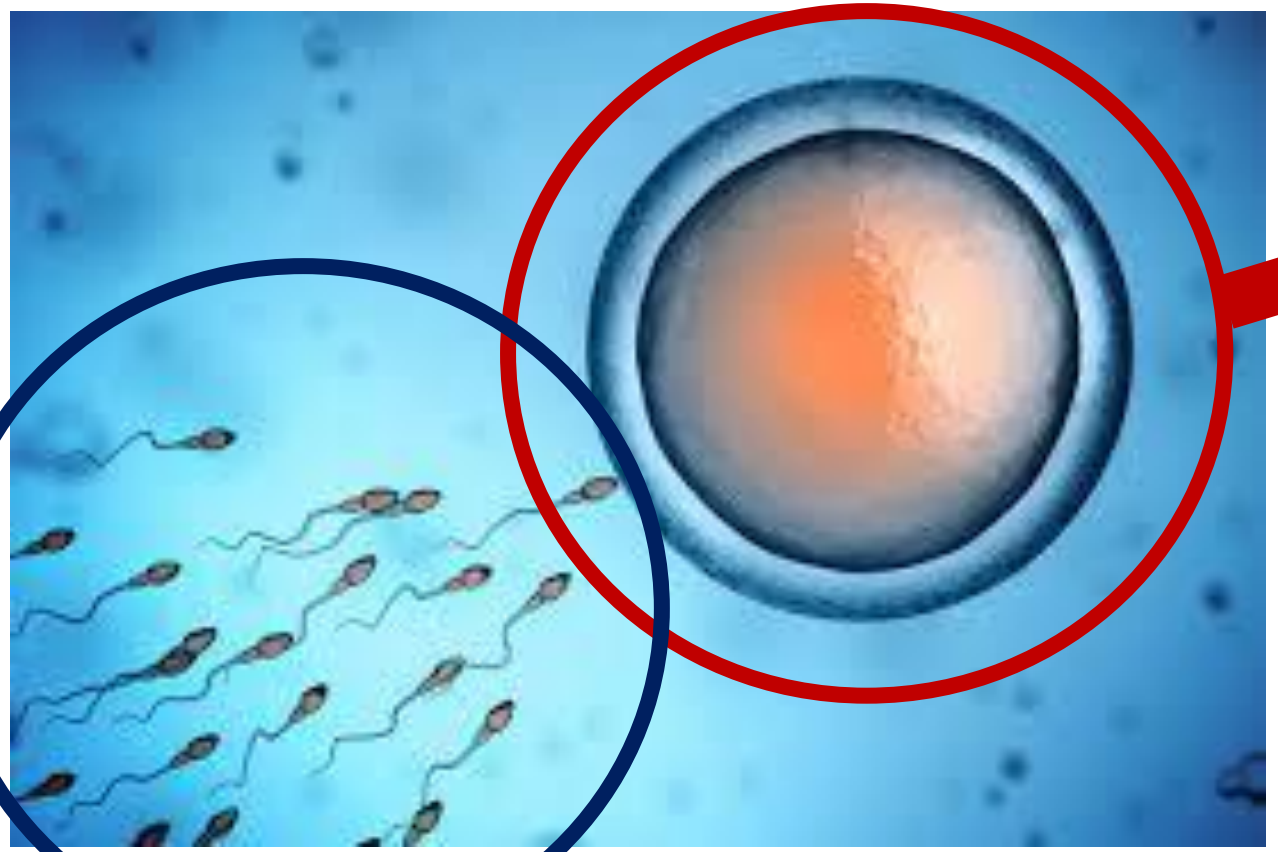


5 Keys to Strong Repro

Fundamentals	Records	First Service	Pregnancy Diagnosis	Semen Type
Cow Comfort Nutrition Handling	Who's bred Who's not When	In early but not too early	Finding and Working the on problems	Getting the right semen to the right cow

1) Fundamentals

Creating a Pregnancy- It Takes Two



How do we make sure a cow is ovulating?

How do we make sure motile high-quality sperm is available at the right time?

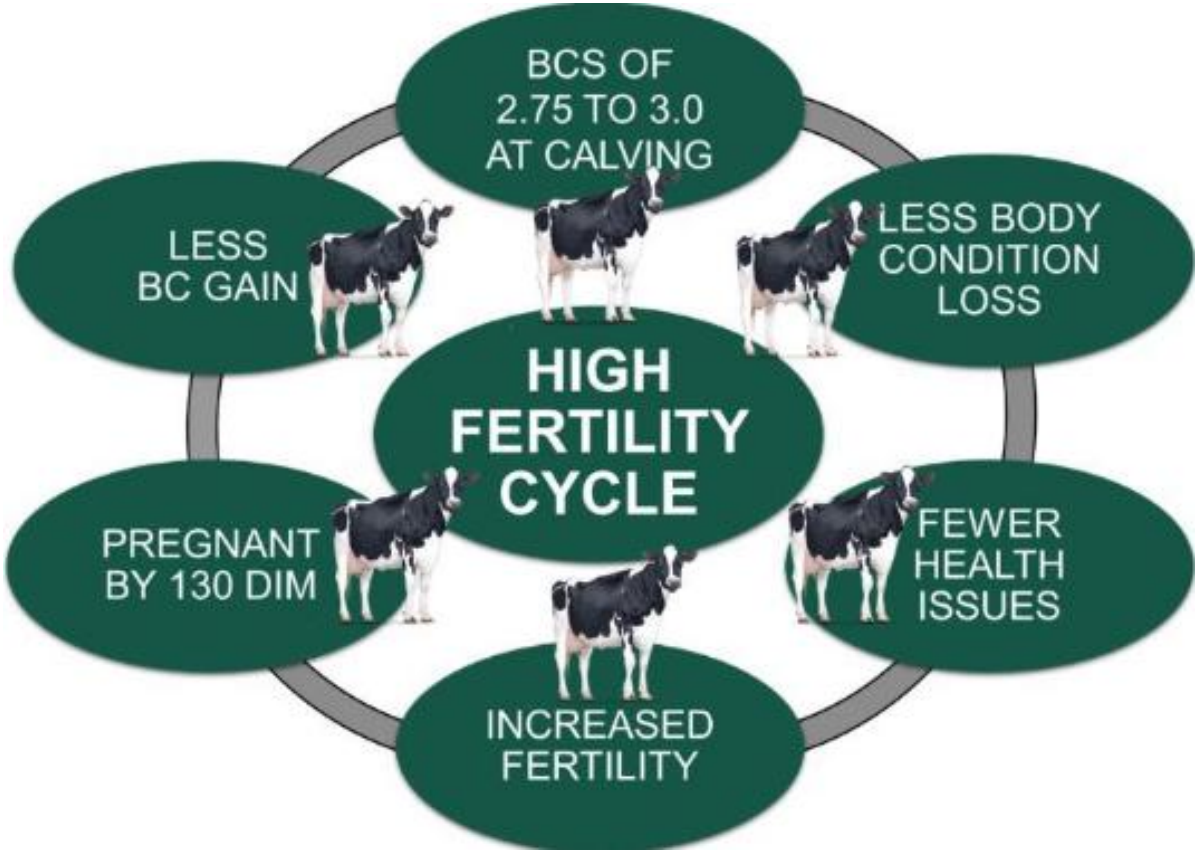
1) Fundamentals

Cow (Egg)

- Fresh Cow Disease
- Negative Energy Balance
- Body Condition
- Lameness
- Heat Stress
- Uterine Health

Insemination Technique (Semen)

- Accurate heat detection
- Insemination Timing
- Semen handling
- Thaw temperature
- Gun placement



Healthy fresh cows become fertile cows!

2) Solid Record Keeping

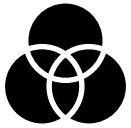
Essential Reproductive Records

- Calving dates
- Breeding dates
- Bull used
- Technician
- Breeding code: Timed AI? Natural heats?
- Pregnancy check results
- Pregnancy Losses

Accurate records allow producers to:


Identify reproductive problems earlier

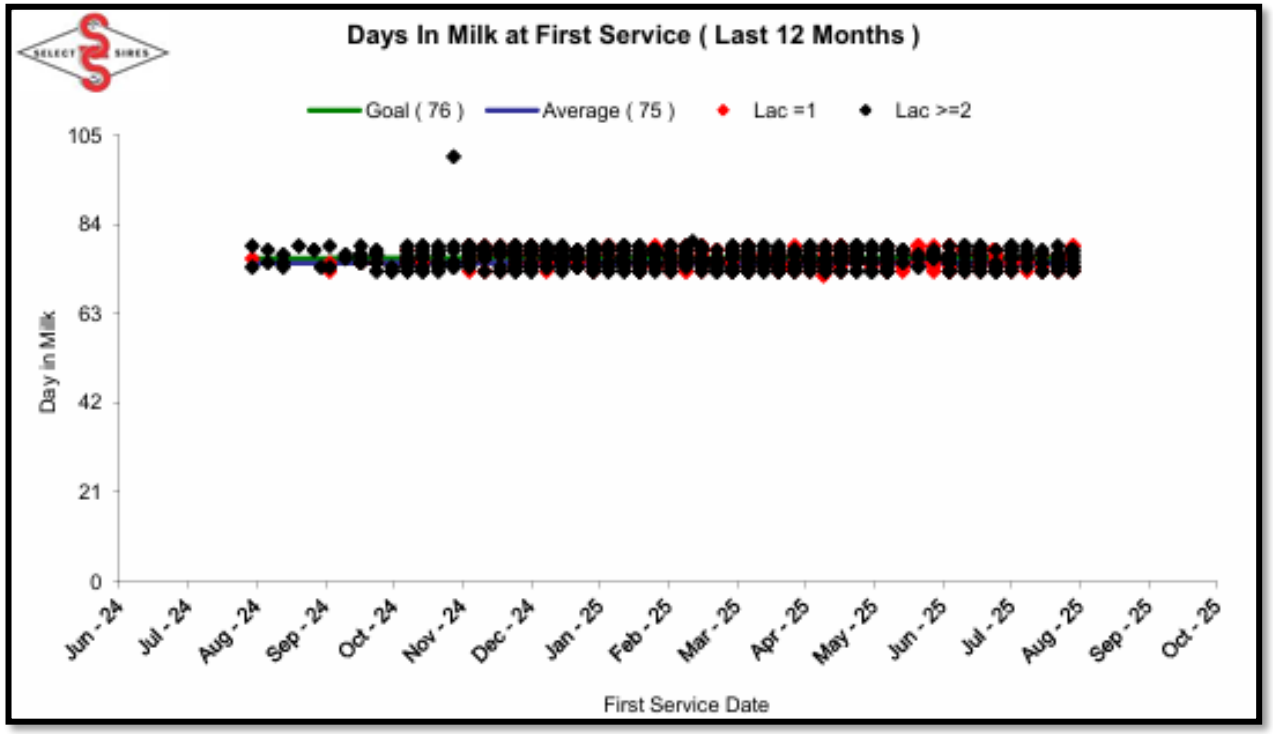

Measure success of breeding programs

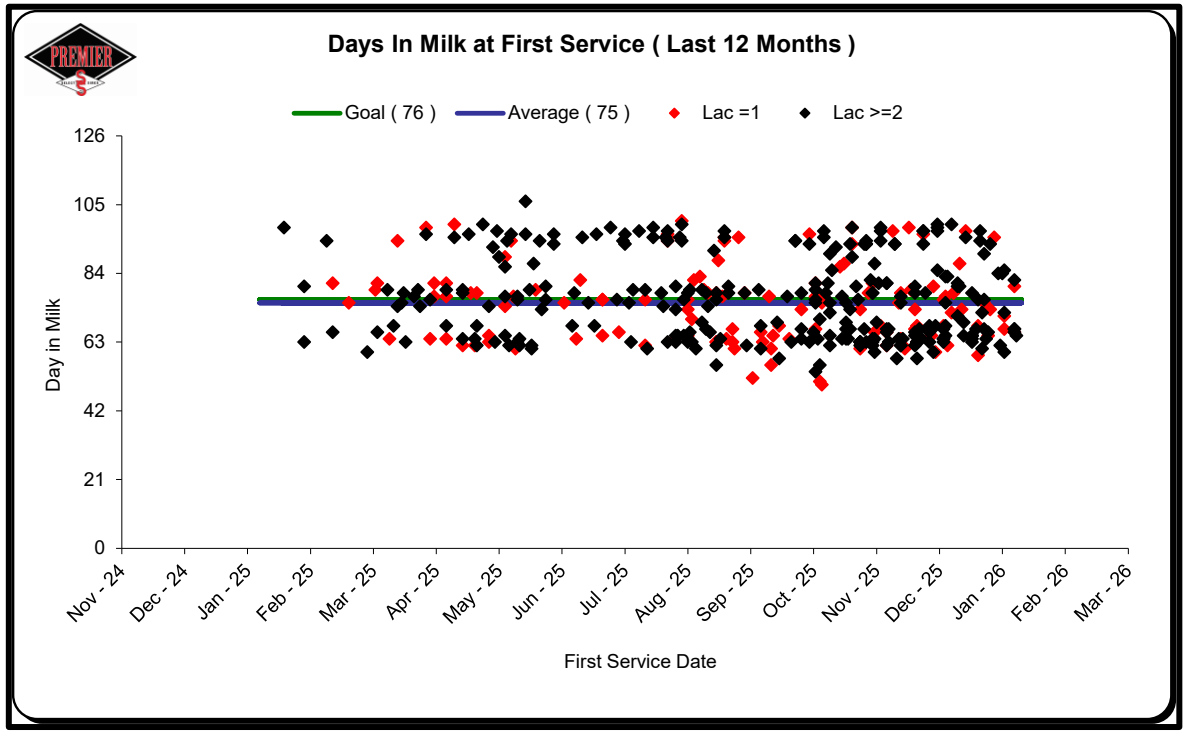

Compare technicians, semen types, and protocols


Make informed culling and breeding decisions

Reproductive programs succeed or fail based on the quality of data behind them

3) Timely + Accurate First Service





First service has the **largest impact on herd reproductive performance.**

3) Timely + Accurate First Service

If a cow conceives at first service:

- Calving interval stays ideal
- Less days open
- Fewer breedings= less hormones, less semen
- Easier BCS maintenance through late lactation/dry period
- Enters peak milk in next lactation faster

Well if 1st service is so important.. Shouldn't I breed as soon as possible??

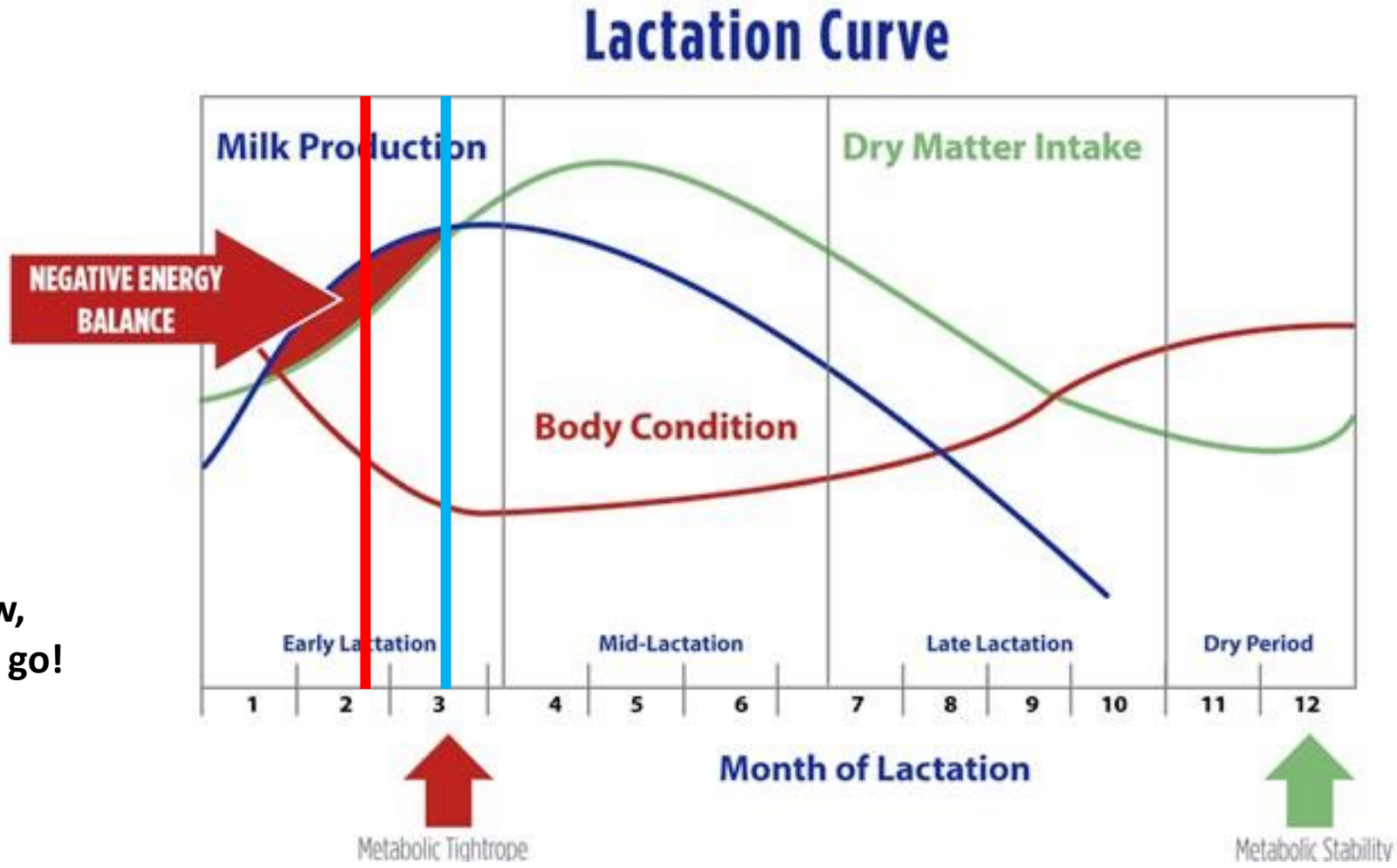
3) Timely + Accurate First Service

There's a difference between:

50 DIM

70 DIM

When energy is low, repro is the first to go!



3) Timely + Accurate First Service

DIM Preg	# Cows	Peak Milk	TD 2 Milk	TD 5 Milk	TD 8 Milk
50-69	38	106.1	103	97	83
70-79	25	119	117	106	93
80-99	9	107.8	105	95	86
100-129	2	121.8	122	108	93
Not SN1	38	130.4	127	113	95

Herd: 240 Cows 51% Conc, 158 DIM 97.8 lbs, 4.1/3.2 7.13 CFP lbs 47% Lact 3+
Parameters: Current Lact 3+ that were pregnant on SN 1
Repro: No shots given until 1 PG at 80 DIM if not serviced

4) Finding the problems – who's pregnant and who's not

- The ones that aren't pregnant after first service need extra attention
- Assuming a 70 VWP + 35 Day Preg Check + 7 Day Resynch
  - 3 Services + Open = 196 DIM
- Find the open cows before vet check!
- High performing herd's have only 20-35% of cows checked for pregnancy turn up open

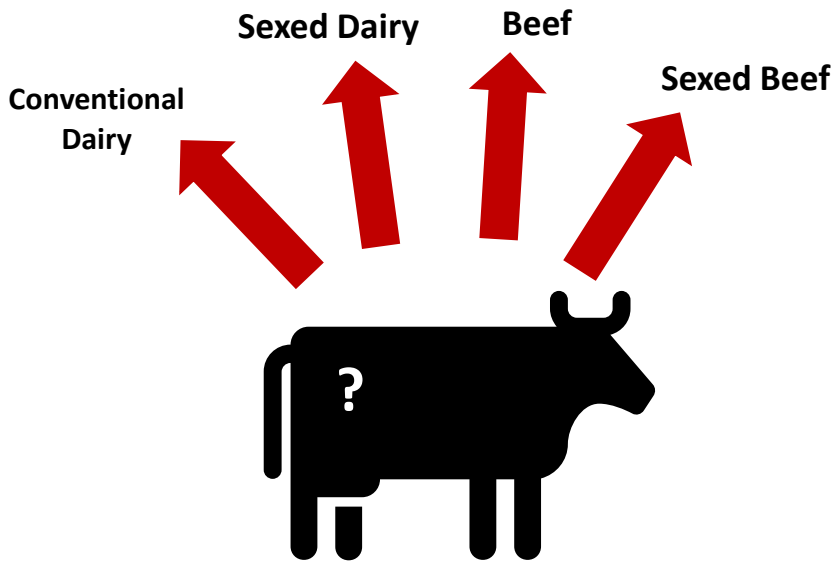
What do we do with the repeats?

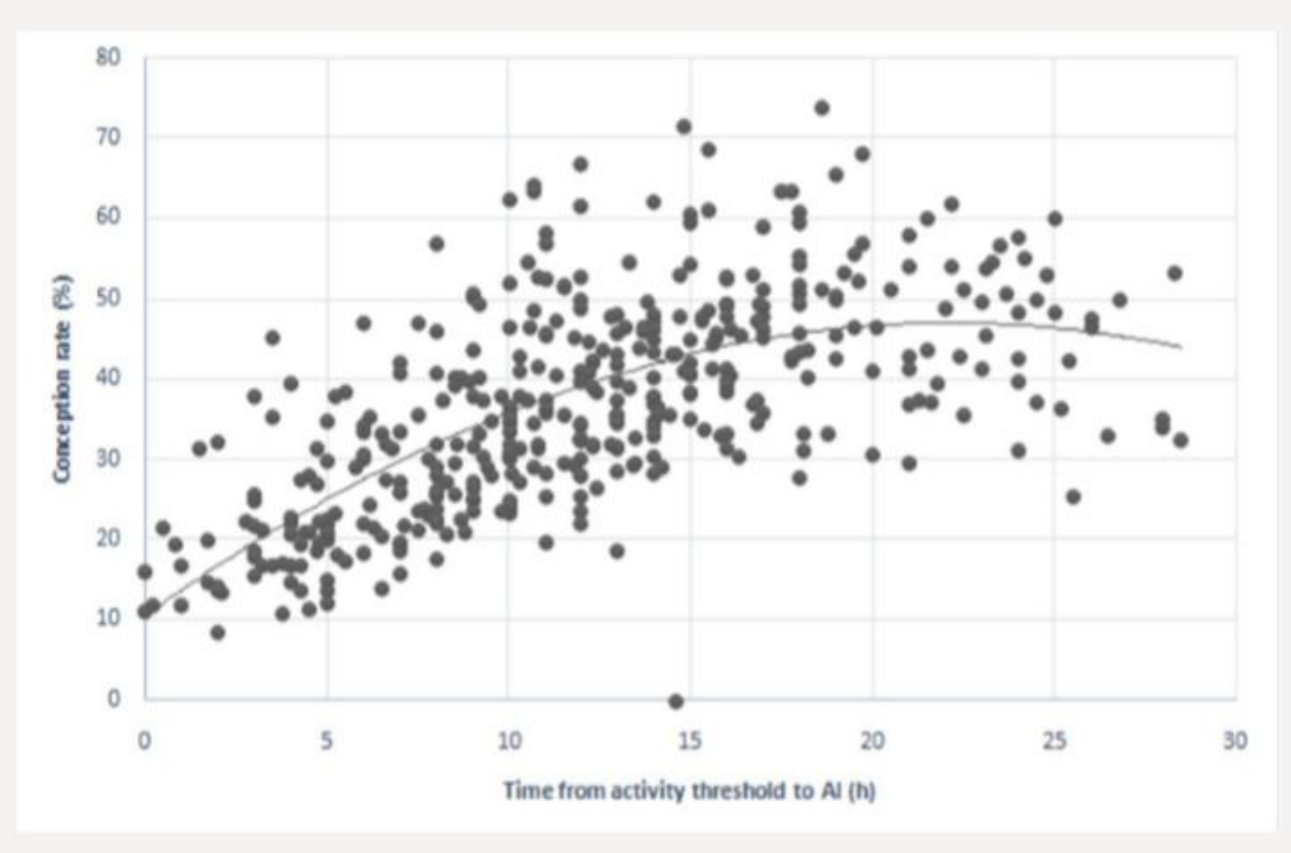
- Accurate heat detection!
- Change semen type
- Intervene with hormones
- Palpate for abnormalities

COWMANAGER®



5) Choosing the Right Semen Type for the Right Cow





Timed AI – GnRH + PG

GnRH
- Gonadotropin Releasing Hormone – LH + FSH
- Follicle Growth + Ovulation

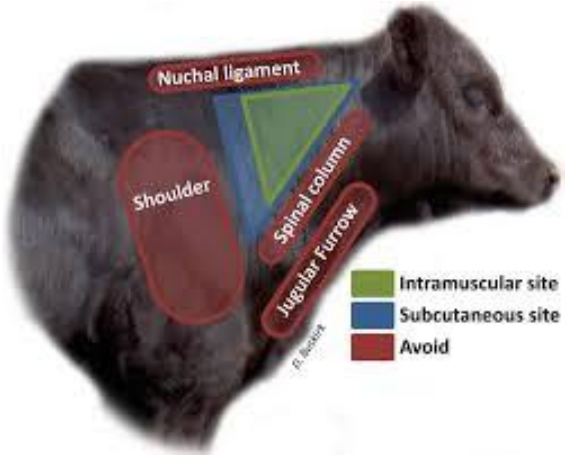
PG
- Prostaglandin
- Regress the Corpus Luteum

CIDR
- Controlled Internal Drug Release
- Releases Progesterone – Body believes she is pregnant

Administering
- Intramuscular
- Try for the meat triangle in neck
- Back of the cow has deep tissue muscle as well





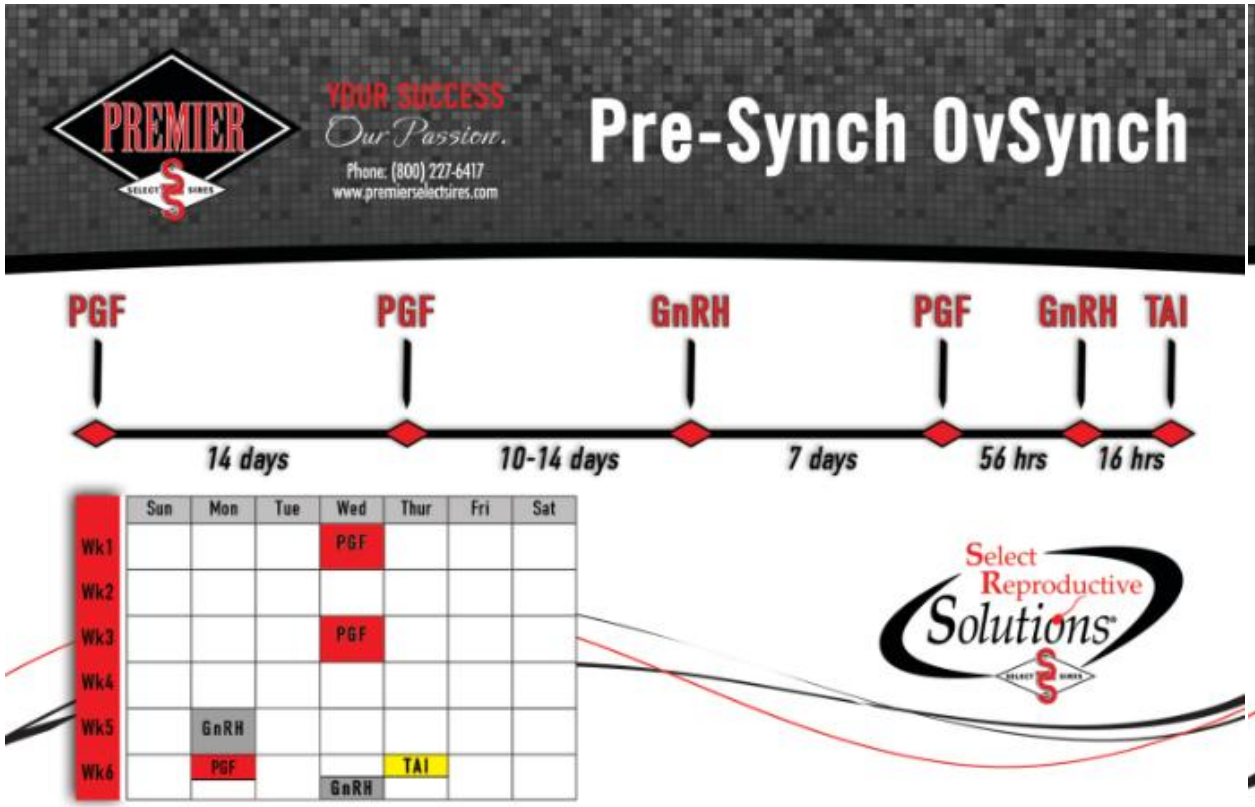


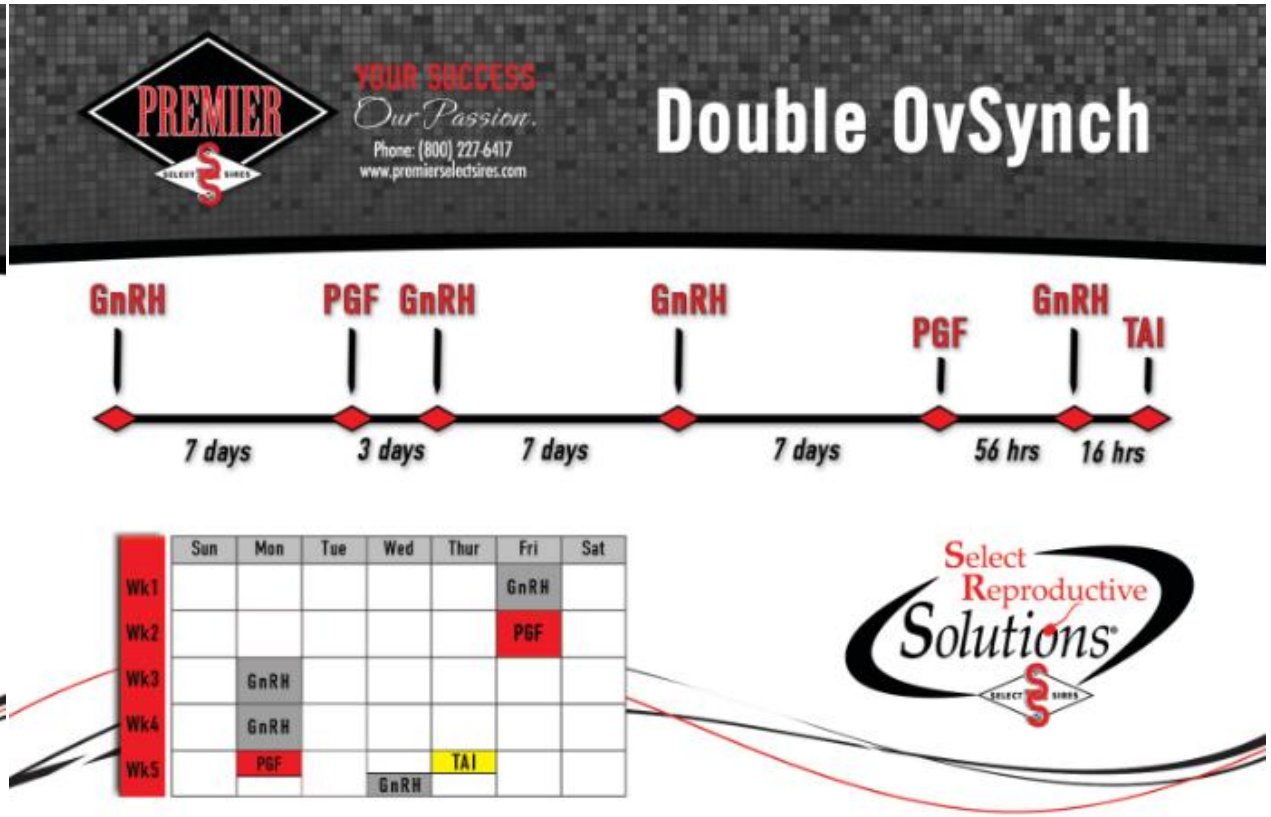
Muscle in the back of the Cow



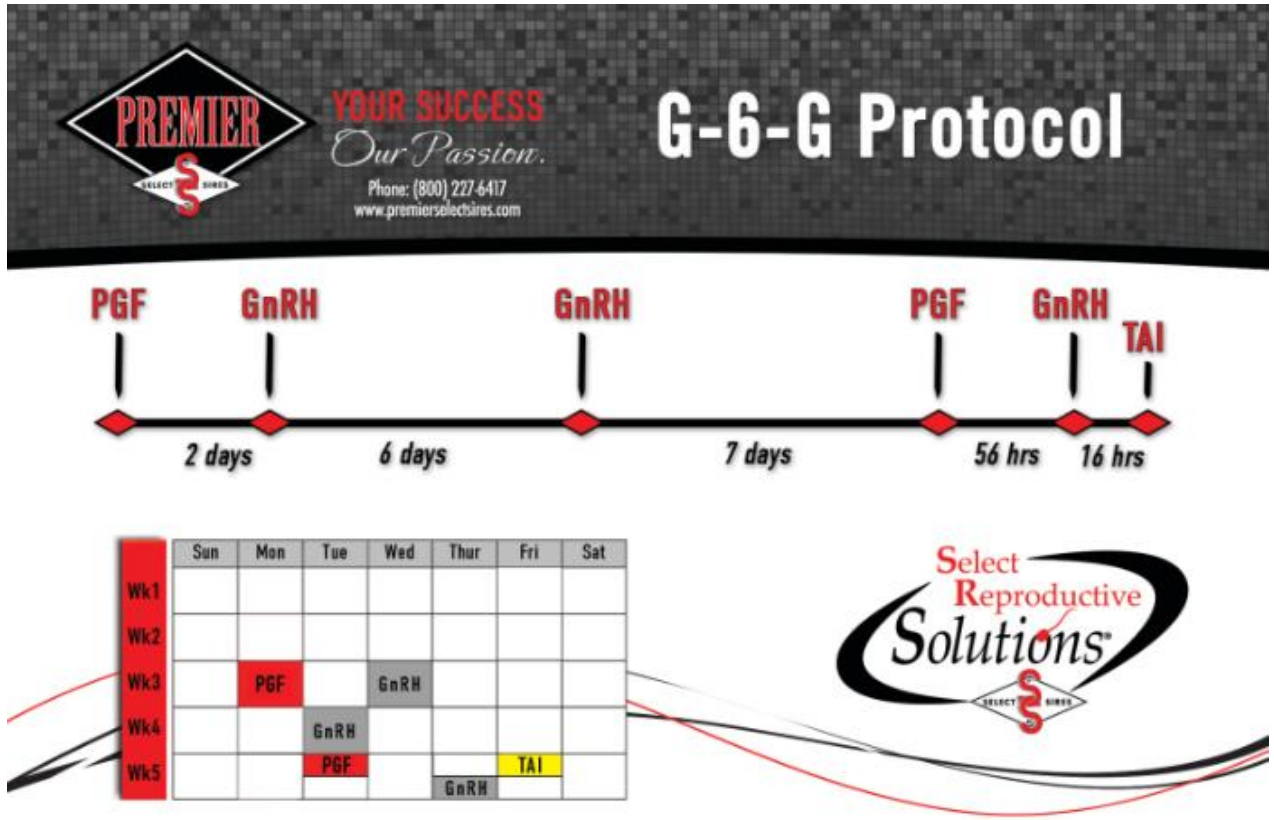


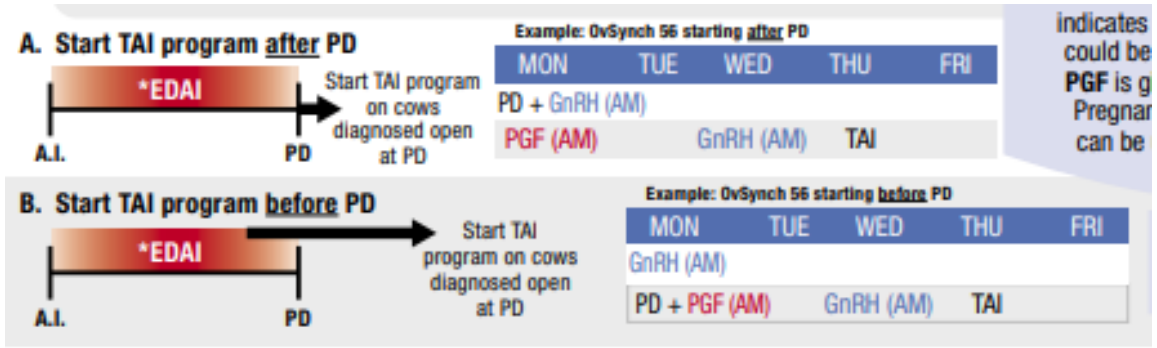
Timed AI Programs to Use – First Service



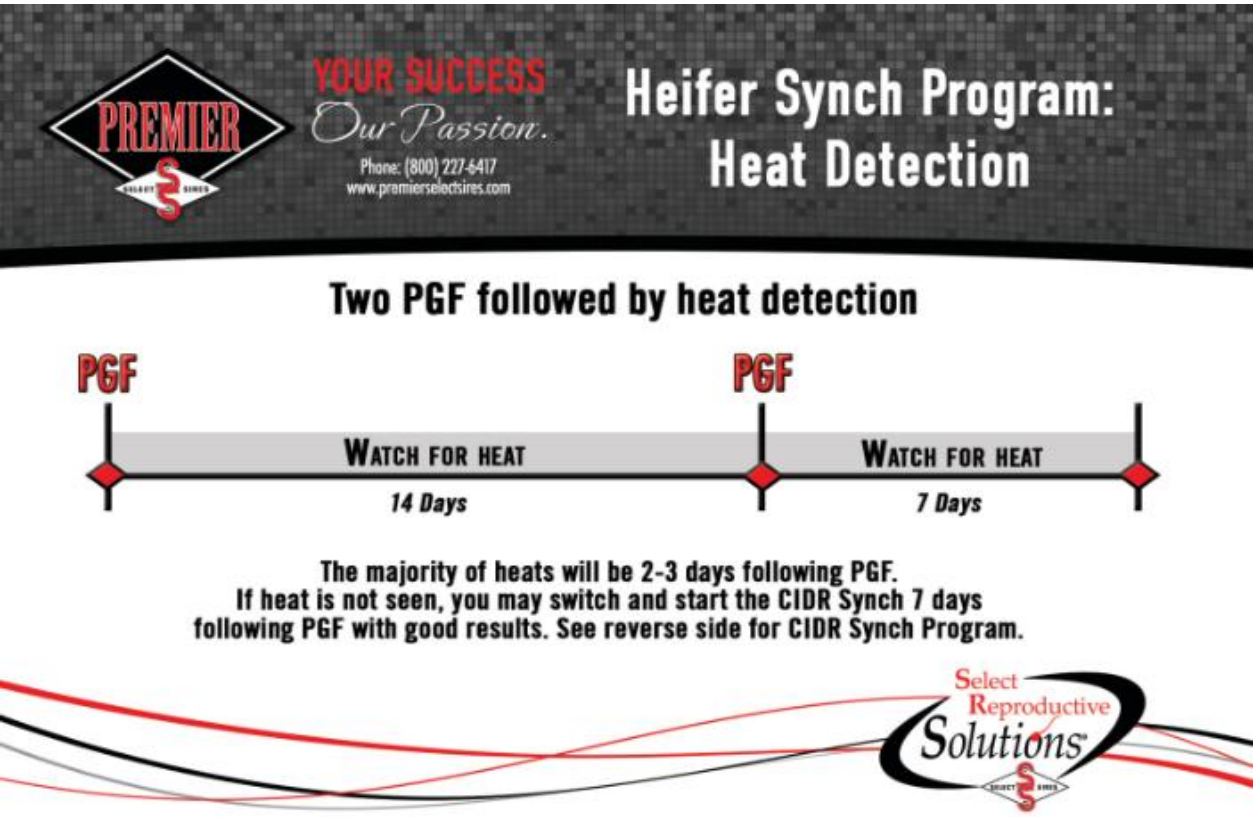


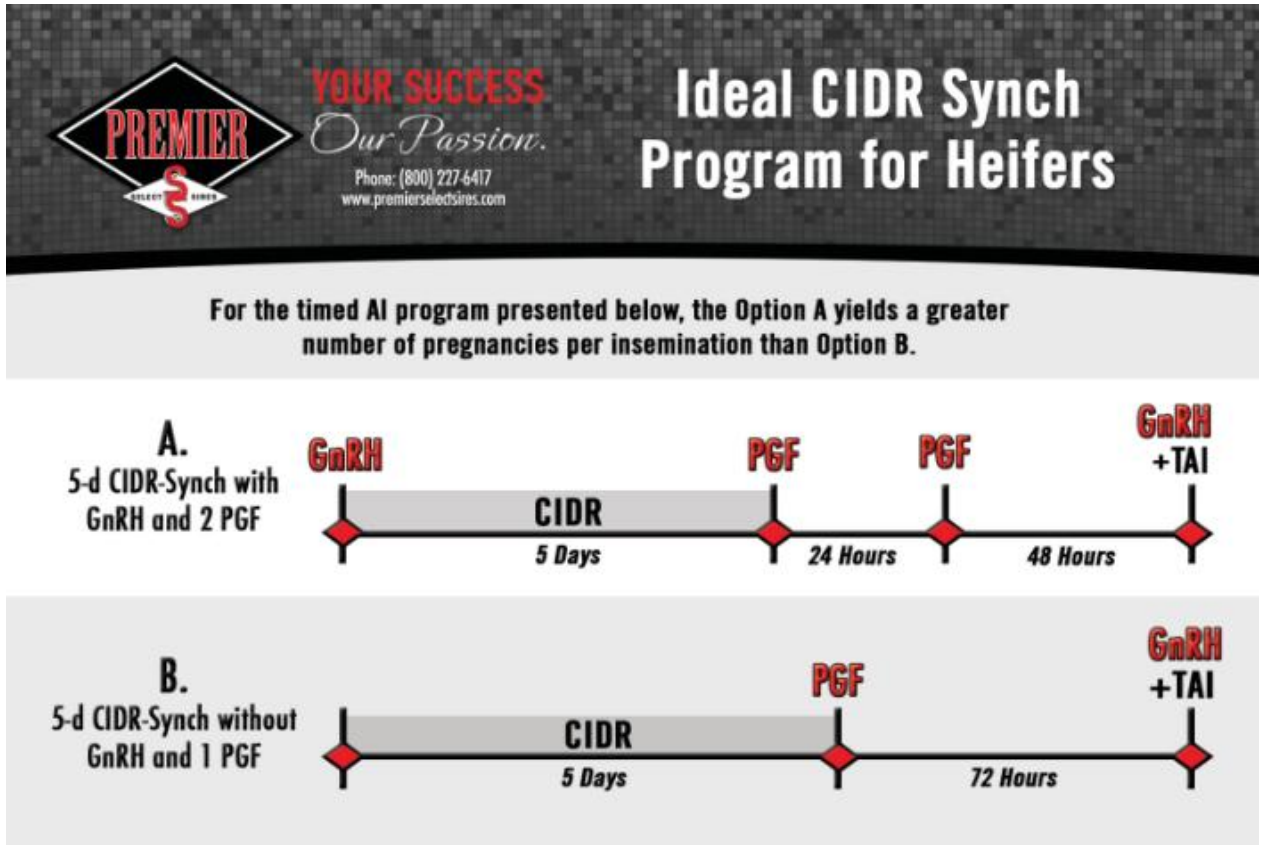
Timed AI Programs to Use





Timed AI Programs to Use





Troubleshooting Repro

Identify where the problem exists	Evaluate Cow Health	Check compliance	Evaluate Semen Handling	Evaluate Environment

• Break conception by:
  • Service #
  • Days in Milk
  • Technician
  • Pen/group
  • Semen Type
  • Lact Group
	• Check:
	  • Metritis
	  • Ketosis
	  • Retained Placentas
	  • Lameness
	  • Body condition loss
		• Analyze heat detection rate
		• Look at service interval
		• Review shot timing
			• Thaw temp 95 degrees for 45 seconds
			• One straw per thaw
			• Inseminate within 15 minutes of thawing
			• Tank management and maintenance
				• Major fertility killers:
				  • Heat Stress
				  • Overcrowding
				  • Stall comfort

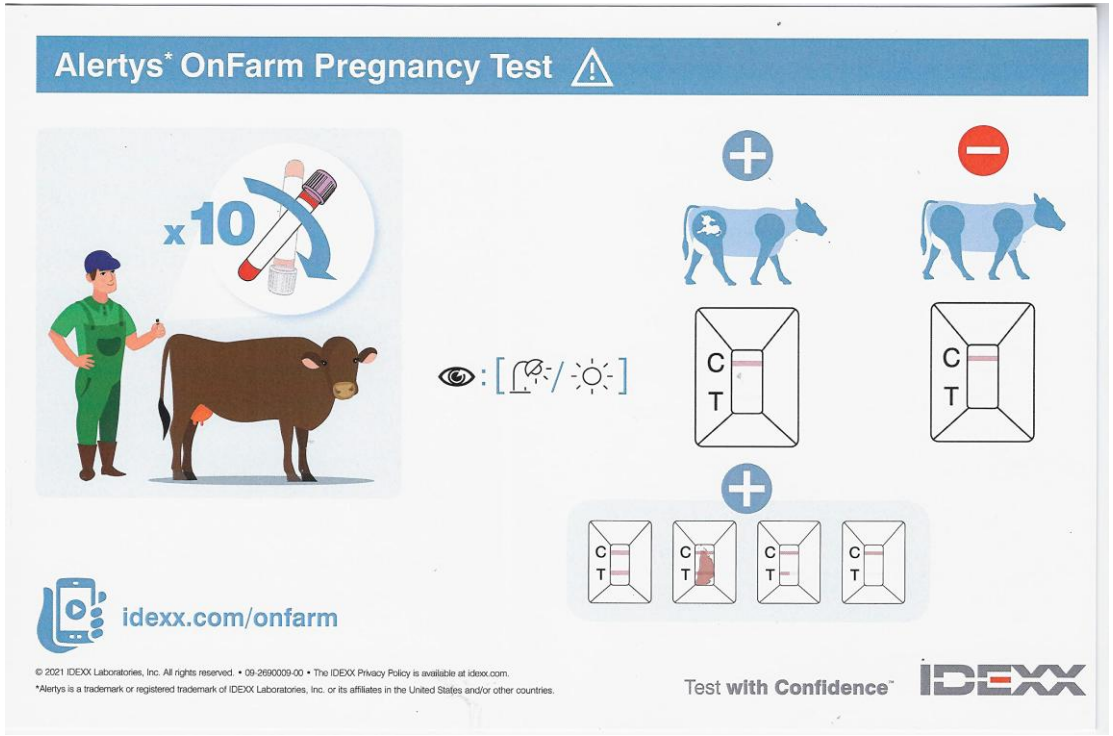
Troubleshooting Repro – Repro Reset

1. Test TMR + Silages for Mycotoxin Levels
2. Reset Genetics to use only highest conception bulls
3. Alter breeding strategy – sexed to conventional
4. Utilize Intense Timed AI (if able to be done 100%)
5. Team buy in – A pregnancy has so many factors at play!

Preg Checking Options

- 19,723 diagnostic records from 46 studies on dairy cows
  - Pregnancy losses averaged
    - Early Embryonic 19-32 days **27%**
    - Late embryonic 30-45 days **13%**
    - Early fetal 45-60 days **7%**
    - Late fetal 60-90 days **2%**

- **Palpation**
- **Ultrasound by a licensed vet**
- **Blood or Milk**



Questions?

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301-514-4638 rallen@premierselect.com

Eli Willard – Area Sales Manager
717-682-0011

Sean Johnson – Regional Sales Manager
301-676-2230



PREMIER BULL CODE BREAKDOWN

EXAMPLE: 507HO11351

STUD CODE — BREED CODE — BULL NUMBER

STUD CODE

STUD CODE	BRAND	SEXED OR CONVENTIONAL
2	TD BEEF SIRES	CONVENTIONAL
6	GUERNSEY GOLD SIRES	CONVENTIONAL
7	SELECT SIRES	CONVENTIONAL
9	UNIVERSAL CODE	CONVENTIONAL
14	ACCELERATED GENETICS	CONVENTIONAL
217	JURA-BETAIL (MONTBELIARDE)	CONVENTIONAL
237	ORIGEN, INC (SIMMENTAL/SIMANGUS)	CONVENTIONAL
250	GENERVATIONS	CONVENTIONAL
294	US/CAN ONLY (RED ANGUS)	CONVENTIONAL
507	SELECT SIRES	SEXED 2M
509	SELECT SIRES	SEXED 4M
514	GUERNSEY GOLD SIRES	SEXED 2M
550	GENERVATIONS	SEXED 2M
557	JURA-BETAIL (MONTBELIARDE)	SEXED 2M
559	GENERVATIONS	SEXED 4M
579	UNIVERSAL CODE	SEXED 2M
585	VERY HIGH PURITY (VHP)	SEXED 2M
614	ACCELERATED GENETICS	SEXED 2M
714	PROFIT SOURCE (BEEF X DAIRY SIRES)	CONVENTIONAL
814	ACCELERATED GENETICS	SEXED 4M

BREED CODE

DAIRY BREED CODES	
AY	AYRSHIRE
BS	BROWN SWISS
GU	GUERNSEY
HO	HOLSTEIN
JE	JERSEY
MO	MONTBELIARDE
MS	MILKING SHORTHORN
RD	RED DANE
SR	SWEDISH RED
XD	CROSSBRED

BEEF BREED CODES			
AN	ANGUS	LM	LIMOUSIN
AR	RED ANGUS	MA	CLUB CALF
BR	BRAHMAN	RB	RED BRANGUS
BM	BEEFMASTER	RR	RED BRAHMAN
BN	BRANGUS	SM	SIMMENTAL & SIMANGUS
CA	CLUB CALF	SP	SHORTHORN
CH	CHAROLAIS		
HH	HORNED HEREFORD		
HP	POLLED HEREFORD		
KB	WAGYU		



Understanding U.S. SIRE PROOFS

1 USDA-CDCB Genomic Eval.			2 (12/24)	2,504 Dtrs. (384 Herds)	3 RIP 96%
Milk	+1,236	99%R	4 Net Merit (99%R)	+$642	
Protein	+0.01%	+40	5 DWP$	+$568	
Fat	+0.11%	+78	Cheese Merit	+$646	

USDA/HA Genomic Evaluation			(12/24) Rel 96%		276 Class. Dtrs.	Age Adj. Avg. 83.8
6 Type +2.20	UDC +3.09		FLC +2.29	BWC -0.38	99%R	GTPI +2503 7

Health and Fertility			(12/24)					
8 SCS	2.76	99%R	9 MAS	+2.0	99%R	10 PL	+3.9	99%R
11 LIV	+3.5	95%R	12 DPR	-0.1	99%R	13 HCR	+1.3	99%R
14 CCR	+1.0	99%R	15 FI	+0.4	99%R	16 SCE	6.0%	99%R
17 WT$	+$90		18 DCE	4.1%	99%R	19 DSB	4.8%	99%R
20 CW$	+$12		21 HHP$	+950		22 SCR	+1.2	99%R

POWERED BY CDCB™

The genetic evaluations contained within this report, unless otherwise noted, are provided by the Council on Dairy Cattle Breeding as the steward of the National Cooperator Database. The National Cooperator Database houses producer-owned yield, management, ancestry, type, and genotype data for the use in genetic evaluations and independent research. Data included in the National Cooperator Database is submitted through certified organizations for data quality and integrity. As such, individual traits - along with Lifetime Net Merit $, Cheese Merit $, Fluid Merit $, and Grazing Merit $ - are Powered by CDCB, unless otherwise noted such as Holstein type traits. For more information about evaluations Powered by CDCB and the industry collaboration that fuels them, visit https://uscdcb.com/cdcb-marks/

1. Origin of data. USDA-CDCB = Domestic production proof; USDA/HA = Domestic Type proof; MACE/M = Interbull

2. Proof month/year

3. Daughters and herds with lactation records that were used in this evaluation. Reliability accuracy increases with more daughters.

4. Net Merit (NM$) measures the expected profit that offspring will provide over its lifetime. The higher the number, the more potential profit.

5. Dairy Wellness Profit Index® (DWP$®) a multi-trait selection index which includes production, fertility, Type, longevity and the wellness traits, including Polled test results. The higher the number, the higher the expected profitability.

6. Type (PTAT), UDC (Udder Comp.), FLC (Feet & Legs Comp.), BWC (Body Weight Comp.), D (Dairy Capacity Comp.), The higher number is better for all traits.

7. Total Performance Index® (TPI®) is a multi-trait index calculated combining production, Type, longevity and fertility into a single value. The higher, the better.

8. Somatic Cell Score (SCS) provides an indicator of mastitis in a bull's daughters based on the direct measure of somatic cells in milk samples. Lower is better.

9. Mastitis (MAS) resistance indicates how resistant a bull's daughters are to mastitis. Higher values are preferred. Evaluations are expressed in percentage points of resistance different from breed average.

10. Productive Life (PL) is the measurement of the number of months a cow is expected to stay in the milking herd. Higher is more favorable.

11. Livability (LIV) is an evaluation of the percent of the bull's daughters that remain alive in the milking herd until they are culled. Higher values are preferred.

12. Daughter Pregnancy Rate (DPR) indicates the pregnancy rate difference expected in lactating daughters of a bull. A higher value is preferred.

13. Heifer Conception Rate (HCR) is a measure of a daughter's ability to become pregnant when bred prior to first calving. These evaluations are expressed as percentage points of conception rate and higher values are preferred.

14. Cow Conception Rate (CCR) evaluates a lactating daughter's ability to conceive when bred. Expressed in conception rate percentage points, higher values are better.

15. Fertility Index (FI) combines several reproductive components into one overall index: ability to conceive as a maiden heifer (HCR), ability to conceive as a lactating cow (CCR) and a cow's overall ability to start cycling again, show heat, conceive, and maintain a pregnancy (DPR).

16. Sire Calving Ease (SCE) measures the tendency of calves to be born more or less easily. Expressed as a percent of difficult births in first-calf heifers, the lower the value, the better.

17. Wellness Trait Index® (WT$®) is a combination of the six cow wellness traits along with polled to directly estimate the additional dollars these traits contribute to overall profit. A higher number is desired.

18. Daughter Calving Ease (DCE) measures the ability of a cow to deliver a calf easily. Evaluations are expressed as percent difficult births in first calf heifers. The lower the value, the better.

19. Daughter Stillbirth (DSB) measures the ability of a bull's daughters to deliver a live calf. Expressed as a percent of still born calves, the lower the value, the better.

20. Calf Wellness Index™ (CW$™) combines evaluations for calf livability, respiratory disease and scours to directly estimate the additional dollars these traits contribute to overall profitability. A higher number is preferred.

21. Herd Health Profit Dollars® (HHP$®) index is an innovative tool to help herds achieve longer-living cows that return the most profit to the dairy.

22. Sire Conception Rate (SCR) is an evaluation of a sire's semen fertility. A higher number is preferred.

	-2	-1	0	1	2	
Stature	Short				Tall	0.25 T
Dairy Form	Tight Rib				Open Rib	0.30 O
Strength	Frail				Strong	0.10 S
Body Depth	Shallow				Deep	0.04 S
Rump Width	Narrow				Wide	0.77 W
Rump Angle	High Pins				Low Pins	0.93 S
Rear Legs Side View	Posty				Sickle	0.08 S
Rear Legs Rear View	Hock In				Square	0.71 S
Foot Angle	Low				Steep	0.71 S
Feet and Legs Score	Low				High	0.72 H
Fore Udder Attachment	Loose				Smooth	1.19 S
Rear Udder Height	Low				High	1.27 H
Rear Udder Width	Narrow				Wide	1.55 W
Udder Cleft	Weak				Strong	0.58 S
Udder Depth	Deep				Shallow	0.68 S
Front Teat Placement	Wide				Close	1.10 C
Rear Teat Placement	Wide				Close	0.92 C
Teat Length	Short				Long	0.59 S

Breeder: Donna P. Nolan, Cambridge, NY — Born: 7/1/2023

Standard Transmitting Ability (STA) block. Displays the STA value for each of the 18 traits. STA is a bull's PTA value on a standardized scale, showing if a bull is more extreme in one trait than another.