National FFA Convention – Dairy: Team Exercise
Genetics and Reproduction Scenario
October 2022

Scenario: Your team is a group of a dairy consultants working with dairy managers to improve the reproduction and genetics on their farms. Recently, you met Fiona and Fred Allen, the owners and managers of FFA Family Dairy. Ms. Allen wants to improve the genetics and reproductive management on her dairy operation and would like your team's advice.

FFA Family Dairy currently has 400 total cows (dry and milking cows) that are housed in a free stall barn in the Northeastern US. The farm is a top producing Holstein herd averaging 27,234 lbs of milk with excellent components which average 4.1% milk fat and 3.3% milk protein. The dairy originally started as a 30-cow operation in the 1980's and has gone through several expansions over the years. The cows are currently milked 3 times a day in a double-16 parallel parlor. As they have expanded, facilities have been built to adequately accommodate all of the calves, heifers, and cows. Stall comfort on the dairy is good and the cows are exhibiting good lying times. The farm has a great relationship with their nutritionist and do not currently have concerns with the nutritional content, mixing, or feeding of the diet for the milking herd or young stock. They would like to maintain a constant number of milking heifers and cows each month throughout the year and are not looking to expand at this time. FFA Family Dairy plans to continue to breed all of their own replacements and will raise them on the farm. They currently have 385 heifers on the farm that range in age from newborn calves to heifers about ready to calve.

The farm uses both an electronic activity system and visual heat detection to detect cows in heat. There are 3 well-trained technicians that artificially inseminate both the cows and heifers, and the technicians are equally skilled with similar conception rates. The farm has provided the following data and information to help with your assessment and advice for the farm.

<u>Lactating Herd:</u>

- Current culling rate: 34%
- 21-day heat detection rate: 66%
- 1st service conception rate: 48%
- 21-day conception rate: 42%
- Services per pregnancy: 1.8

<u>Replacement Herd:</u>

- 1st service conception rate: 59%
- Percentage of heifers born alive that calve on the dairy. (These are surviving heifers that are healthy, bred prior to 18 months of age, and not selectively culled for other reasons.): 75%
- Average age at first calving: 24 months

Concern #1 – Herd Reproduction

Ms. Allen would like you to help her gain a better understanding of the status of her current reproduction program compared to industry averages. Some of the questions she has for you are:

- What is pregnancy rate?
- What is the 21-day pregnancy rate on her farm?
- What is your assessment of this farm's pregnancy rate compared to industry averages?
- Give advice to FFA Dairy on ways they could improve the farm's pregnancy rate.

Concern #2 – Number of Herd Replacements Needing to Be Raised

Ms. Allen has recently been reading in popular press that farms may be more profitable raising the number of dairy heifers needed for replacements compared to farms that raise too many heifers. She would like to know how many heifers you think they should be raising on the farm to maintain herd size without having a surplus of heifers.

- Discuss the factors on the farm that will determine the number of heifers that are needed by FFA Dairy to maintain herd size.
- How many heifer calves need to be born each year to make sure that FFA Dairy can maintain their current herd size? Clearly explain how you determined this number.
- What are the positive and negatives of the farm raising the number of calves you determined?

Concern #3 – Using Specially Selected Beef Sires to Breed Dairy Cattle – "Beef on Dairy"

Ms. Allen has also been reading that breeding a percentage of the dairy cows to beef sires selected for improved average daily gains and carcass characteristics is a good way to increase the selling price of bull calves and can increase farm profits. FFA Family Dairy is considering breeding 40% of their mature dairy cow herd to beef sires to be able to sell the crossbred offspring for the beef market. They have already chosen beef bulls that have been specifically selected for mating with Holsteins to get high quality offspring for the beef market.

- How many straws of "beef-on-dairy" semen would they need to order each year (assuming current herd averages)?

- Although the bull calves will be worth more and selling them will bring more profit to the dairy, Ms. Allen would like to know what factors they need to consider if they implement the strategy to breed 40% of their mature cows to beef sires. Are there certain practices you would recommend when she breeds either the mature dairy cow herd or virgin dairy heifers?

Concern #4 – Using Genomic Data to Improve the Herd

FFA Family Dairy has heard that using genomic data can help them make better selection decisions for the future of their dairy. They recently sampled young heifers and sent the samples off for genomic analysis. The farm has shared some of the genomic data with you (Table 1), and would like your opinion on the following questions.

1.) Which of these 2 animals would you cull from the farm based solely on expected lifetime profit and why?

2.) FFA Family Dairy is interested in selecting for an A2A2 herd. Which of these animals would you select if being an A2A2 herd was the farm's goal?

3.) FFA Family Dairy is interested in working towards a polled herd of Holsteins. What would you do to work towards a polled herd? Why would it be important to breed for polled animals?

4.) One of the items listed on the genomics table are health traits. Why are they important?

5.) After compiling the data and learning that only 75% of heifers make it to calving, the farm would like to do what they can to improve calf and heifer survivability. Which of the genomics traits would be helpful to increase the percentage of heifers that stay in the herd and make it to calving?

Table 1. Genomic Data from 12 Heifer Calves from FFA Family Dairy.

On-farm ID	NM$	TPI	Milk	Fat	Prot	DPR	PL	LIV	CA$	BLAD	DUMPS	Brachyspina	Horn/Polled	Beta Casein A2
12	603	2415	377	51	24	0.4	5	2.3	-4.8	F*	F*	F**	TP*	A1/A1*
19	434	2301	908	32	14	-0.1	4.2	1.7	12.7	F*	F*	F**	TP*	A1/A2*
21	266	2159	-233	22	-6	0	3.2	2.9	5.3	F*	F*	F**	TP*	A1/A2*
33	379	2346	1243	26	28	-0.1	3.1	0	15.3	F*	F*	F**	TP*	A1/A1*
39	473	2384	1118	41	30	-1.1	3.2	1.5	16.4	F*	F*	C**	TP*	A2/A2*
45	384	2333	-389	48	5	0.6	3.2	2.6	7.6	F*	F*	F**	TP*	A2/A2*
53	525	2369	1675	40	43	-1.9	3.6	0.2	17.9	F*	F*	F**	TP*	A1/A2*
68	383	2278	335	62	20	-2.9	0.3	-1.2	-11.7	F*	F*	F**	TP*	A1/A2*
73	112	2132	525	7	12	-0.4	1.8	-0.4	11	F*	F*	F**	TP*	A1/A1*
77	541	2411	1067	39	26	1.3	4.8	3.2	14.1	F*	F*	F**	TP*	A2/A2*
82	108	1978	97	11	4	-0.7	0.6	0.8	1.7	F*	F*	F**	TP*	A2/A2*
99	313	2122	-61	29	1	1.4	3.2	3.5	18.5	F*	F*	F**	TP*	A1/A2*

Trait	Units	Descriptions
Net Merit (NM$)	$	
Total Performance Index (TPI)	Index points	
Milk Yield (Milk)	lbs	
Fat (Fat)	lbs	
Protein (Prot)	lbs	
Daughter Pregnancy Rate (DPR)	percent	An increase of 1.0 percent in DPR equals an approximate decrease of four days open.
Productive Life (PL)	months	Evaluates a cow's genetic ability to stay in the herd and accounts for characteristics that make a cow more sustainable for the dairy operation. It is expressed as the expected months in milk that a cow will have relative to the breed average.

Livability (LIV)	percent	Evaluates a cow's genetic ability to stay alive on the farm. It is expressed as the percent of progeny that will stay alive relative to the breed average. This is different from the other longevity trait (PL) that focuses on removal from the herd due to mortality and culling. Higher values for livability are more desirable.
Calving Ability (CA$)	$	Genetic index that measures the ability of a calf to be born easily and alive. Specific traits used in the CA$ index include sire calving ease, daughter calving ease, sire still birth and daughter still birth.
Bovine Leukocyte Adhesion Deficiency (BLAD)		"A" Affected,"C" Carrier,"F" Free. A congenital disease that results in cattle with chronic infection, stunted growth, and early death. Carrier animals do not exhibit the disease, but have a 25% chance of producing an affected calf when bred to another carrier. An NR indicates no result available.
Deficiency of Uridine Monophosphate Synthase (DUMPS)		"A" Affected,"C" Carrier,"F" Free. Calves with DUMPS are aborted early in gestation. Carrier animals do not exhibit the disease, but have a 25% chance of producing an affected calf when bred to another carrier. An NR indicates no result available.
Brachyspina		"A" Affected,"C" Carrier,"F" Free. Calves with Brachyspina are typically aborted within the first 40 days of gestation, but a small number survive to birth and are born with reduced body weight, short body and neck, and a visible hump between their shoulder blades. Carrier animals do not exhibit the disease, but have a 25% chance of producing an affected calf when bred to another carrier. An NR indicates no result available.
Horn/Polled		Tested Homozygous Polled (PP) – these animals will always pass a Polled gene to their offspring as they carry two alleles of the polled gene, Tested Heterozygous Polled (PC) – carrier of polled allele thus are observed Polled but carry a horned gene, Tested free of the Polled Condition (TP) – these have horns. “Indeterminate” (I) will be assigned where standard genomic testing information is not able to determine the result. The Polled condition is a dominant trait, however the gene frequency in dairy breeds is very low for the polled gene. When two heterozygous polled animals are bred together, the resulting calves have a 25% chance of being horned. An NR indicates no result available.
Beta Casein A2		Characterization of the Beta-Casein content produced in milk. A2/A2 is the most desirable genotype. An NR indicates no result available.

Answer Key:

Strengths of FFA Dairy:

- Very well managed herd
- High production and total solid yields
- Managers are continuously looking to improve management of the herd and incorporate newer management practices.
- As will become evident—extremely well managed reproductive program (good heat detection and conception rates)

Concern #1 – Understanding what pregnancy rate is (and in comparison to conception rate) and what are industry benchmarks for this reproductive measure. (The most important concept in this scenario)

- What is pregnancy rate and what is the 21-day pregnancy rate on her farm?

Conception Rate reflects the percentage of cows which have been bred that conceive. This measure of fertility does not account for pregnancy losses between 30 to 60 days bred since cows are checked pregnant around 30 days. Some have also referred to this as pregnancies/AI (Preg/AI). Goal: 45-55% of cows bred are pregnant within a 21 or 30 day period.

Pregnancy Rate reflects percentage of cows pregnant within a 21-day or month in relation to the total number of cows in the breeding herd. This value reflects the success rate of getting cows pregnant. Pregnancy rate is a function of insemination (heat detection rate) and conception rates. Goal: Greater than or equal to 24-26%. Improvements in pregnancy rates increase profit. When pregnancy rates are around 15%, an insufficient number of heifers are born yearly to serve as replacements for the dairy herd. Generally speaking, pregnancy rates need to be around 20% to produce enough replacement heifers.

Pregnancy rate can be calculated by multiplying heat detection rate by conception rate.

$$\text{Pregnancy rate} = \frac{\text{\# cows pregnant}}{\text{\# cows eligible to be bred within a 21 or 30 day period}}$$

For this farm, the preg rate is:

Preg Rate = 0.66 (Heat detection rate) X 0.42 (21-day conception rate) = 0.2772 or 28%

- What is your assessment of this farm's pregnancy rate compared to industry averages?

  This dairy's 21-day pregnancy rate is ABOVE Industry standards

- Give advice to FFA Dairy on ways they could improve the farm's pregnancy rate.

  Keep up the good work at detecting cows in heat and getting semen correctly into cows in a timely and correct manner

Concern #2 – Calculate the number of herd replacements needing to be raised

- Discuss the factors on the farm that will determine the number of heifers that are needed by FFA Dairy to maintain herd size.

  - The culling rate of the herd
  - The age at which heifers calve in
  - The percentage of heifers that do not reach calving, which is impacted by:
    - Calf mortality
    - Heifer mortality
    - Voluntary culling of heifers
    - Non-breeding heifers

- How many heifer calves need to be born each year to make sure that FFA Dairy can maintain their current herd size? Clearly explain how you determined this number.

  Number of heifers needed to replace culled cows

  400 cows X 0.34 (Culling rate) = 136 springing heifers needed annually at 24 mo – avg. age of first calving

  Number of heifers needed to account for calf and heifer losses, non-breeders, and preg heifers culled at 75% survival of 24 hr old calves through calving - increase numbers heifers needed by 25%

  136 springers x (1 + 0.25 (non-completion rate)) = **170** 24-hr old calves/year needed in heifer program

  Overton Data - 10% Calf losses < 13 mo, 7% non-breeders, and 6% preg heifers culled (In addition, there are 6% stillbirths- which for this age group we did not account for)

Total heifer herd at these calculations and dairy assumptions = 170 heifers/year or around 340 heifers in heifer herd. Currently have 385 heifers.

Industry usually expects the heifer herd to contain 75-80% of the number of cows found in milking + dry herd. For this herd that would be around 320 heifers @ 80%.

- Discuss the positives and negatives of FFA Dairy going to this number of heifers.

  Positives: Reduce total cost to raise replacements and hopefully increase profitability of dairy business, use feed resources to support milking cows

  Negatives: If culling rate needs to increase or reproduction efficiency decreases, heifer replacements may be limiting.

Concern #3 – Breeding Beef Sires to Dairy Cattle – "Beef on Dairy"

- How many straws of "beef-on-dairy" semen would they need to order each year (assuming current herd averages)?

  400 cows X 1.8 straws/cow x 0.40 (% herd bred to "beef-on-dairy sires") = 288 straws needed

  (Yes, there may be differences in semen fertility between semen types (sexed vs conventional, beef-on-dairy vs dairy semen) —but a concept for a more advanced audience.)

- Although the bull calves will be worth more and selling them will bring more profit to the dairy, Ms. Allen would like to know what factors they need to consider if they implement the strategy to breed 40% of their mature cows to beef sires. Are there any practices you would recommend when she breeds either the mature cow herd or virgin heifers?

  Use of sexed semen, especially in virgin heifers, would increase the number of Holstein heifers born on the dairy. This will be important to maintain herd size with the large number of cows being bred to beef bulls.

  Breeding this many cows to beef sires will reduce the number of Holstein replacement heifers potentially being born from the mature cow herd as any heifers born will also be beef crosses and also be sold for beef.

The use of genomics would allow Ms. Allen to continue to breed the best cows to Holstein genetics.

Concern #4 – Using Genomic Data to Improve the Herd

1.) Which of these 2 animals would you cull from the farm based solely on expected lifetime profit and why?

Net Merit $ index expresses the expected lifetime profit of a female compared to the breed base. NM$ utilizes economically relevant traits related to yield, health, longevity and calving ease. Specific traits used in the index include fat and protein yield (therefore also milk), productive life, daughter pregnancy rate, somatic cell score, udder composite, feet & leg composite, body size, and calving ability (including stillbirth information).

On-farm ID	NM$
12	603
19	434
21	266
33	379
39	473
45	384
53	525
68	383
73	112
77	541
82	108
99	313

2.) FFA Family Dairy is interested in selecting for an A2A2 herd. Which of these animals would you select for if being an A2A2 herd was the farm's goal?

The A2/A2 genotype means the cows are homozygous for the A2 Beta Casein gene.

On-farm ID	Beta Casein A2
12	A1/A1*
19	A1/A2*
21	A1/A2*
33	A1/A1*
39	A2/A2*
45	A2/A2*
53	A1/A2*
68	A1/A2*
73	A1/A1*
77	A2/A2*
82	A2/A2*
99	A1/A2*

3.) FFA Family Dairy is interested in working towards a polled herd of Holsteins. What would you do to work towards a polled herd? Why would it be important to breed for polled animals?

These heifers all tested “free of the polled condition”. For them to have polled offspring, they will need to be bred to a homozygous polled sire.

Polled cattle do not need to be disbudded and there is no concerns of them growing horns that can be dangerous to both humans and other cattle.

4.) One of the items listed on the genomics table are health traits. Why are they important?

Bovine Leukocyte Adhesion Deficiency (BLAD)- congenital disease- early death , Deficiency of Uridine Monophosphate Synthase (DUMPS)- cause early abortions, Brachyspina- cause abortions < 40 days of gestation

5.) After compiling the data and learning that only 75% of heifers make it to calving, the farm would like to do what they can to improve calf and heifer survivability. Which of the genomics traits would be helpful to increase the percentage of heifers that stay in the herd and make it to calving?

Improved reproduction—DPR Daughter pregnancy rate, Cow conception rate, Heifer conception rate, Holstein fertility index

Decreased stillbirths

Calving ability $

Livability

Productive Life

Zoetis also has genomic data for calf livability, calf scours, calf respiratory disease and a Calf Wellness index that combines these traits (note that these were not included in this scenario, but they are available)