Using Genomics for Selection in Dairy Cattle

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OUTLINE

Using Genomics

1. Selection & Mating

- When to genotype
- Who to genotype

2. Exercise using visual, pedigree information and heifer information

- Selection
- Mating

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WHEN TO GENOTYPE

BREEDING OBJECTIVES

Breeding objectives determine when to genotype

- What are your goals for your dairy?
- When do you want to sort your females?

BEFORE WE GENOTYPE…

Identifying goals and choosing priorities

- Identify replacements
- Identify females that won't produce replacements
  - Breed to beef bulls
  - Breed to less expensive bulls
- Identify elite females
  - Sexed semen
  - Assisted Reproductive Technologies
  - Breed to better bulls
- Reduce effects of early disease
- Reduce generation interval

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GENOTYPING EARLY

- Identification of replacements and elite females to sort heifers early for different levels of care
- Facilitates reducing generation interval by using assisted reproductive technologies
- Potential to further increase genetic progress

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AFTER WEANING OR AFTER CO-MINGLING

Stratify females before breeding but with knowledge of resistance to BRD, scours, etc.

- Sort into breeding strategies by overall quality using selection indexes or to maximize complementarity with additional emphasis on specific traits
- Keep or cull

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WHO TO GENOTYPE

BREEDING OBJECTIVES INFLUENCE WHO IS GENOTYPED

- Genotype more animals than you plan on keeping for replacements or elite females

- More you genotype, the choosier you can be for selecting your replacements resulting in faster genetic progress

- Genotyping more animals improves accuracy of keeping the right individuals

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SUMMARY

- When genotyping is done and what cattle are genotyped should reflect the goals of the dairy
- Genomic selection increases the genetic progress of the dairy herd
- Genomic selection reduces financial risk by reducing the risk of animals who are poor performers

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EXERCISE

Compare visual, relative and heifer genomic selection information on the heifers in your handouts

1. Would your selection decisions or rankings change if you used pedigree-based selection compared to genomic selection?
2. How are you measuring profitability and how does this match your PTAs?
3. How would this affect your profitability?
4. Which PTAs would you expect to be less affected by genomic selection?
5. Once you have selected the heifers, make decisions on who are elite, average and below average and how they would be mated.
6. Choose bulls from the handout for the heifers you selected based on their PTAs and your decisions in #4.

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HANDOUT

In the Packet:

1. Selection/mating – you choose

- 20 heifers with pictures for visual assessment (phenotypic selection), pedigree information and individual genomic PTAs
- 4 bulls with PTAs and pictures

2. Economic selection indexes and their weights for each trait to determine if/which index you would like to use

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EXAMPLE

Fluid Milk

1 Visual assessment

Pedigree information

Heifer	Sire Milk	Sire/Maternal Grandsire
1	422	345

What does a predicted transmitting ability (PTA) of 422 mean?

On average, that sire's offspring would produce 422 pounds more milk than average.

1 Visual assessment

Pedigree information

Heifer	Sire Milk	Sire/Maternal Grandsire
1	422	345.84

Heifer genomic information

Heifer	FM$	CM$	NM$	GM$	Milk	Fat (%)	Fat (lbs)	Pro (%)	Pro (lbs.)	SCS	PL	CCR	HCR
1	350	357	357	333	805	-0.06	15	0	26	3.05	2.5	0.8	0.5

WHAT DOES HER PTA MEAN?

Heifer genomic information

Heifer	FM$	CM$	NM$	GM$	Milk	Fat (%)	Fat (lbs)	Pro (%)	Pro (lbs.)	SCS	PL	CCR	HCR
1	350	357	357	333	805	-0.06	15	0	26	3.05	2.5	0.8	0.5

What does a predicted transmitting ability (PTA)for fluid milk of 805 for this heifer mean?

On average, her offspring would produce 805 pounds more milk than the average.

2 Visual assessment

Pedigree information

Heifer	Sire Milk	Sire/Maternal Grandsire
2	-246	251

Heifer genomic information

Heifer	FM$	CM$	NM$	GM$	Milk	Fat (%)	Fat (lbs)	Pro (%)	Pro (lbs.)	SCS	PL	CCR	HCR
2	212	291	282	265	-482	0.15	22	0.05	0	2.92	2.3	0.6	0.9

1

2

3

4

5

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FLUID MILK RELATIVES' EXAMPLE

Heifer	Sire Milk	Sire/Maternal Grandsire
1	422	345
2	-246	251
3	2252	1708
4	830	579
5	1253	438

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HEIFER'S PTA EXAMPLE

Heifer	FM$	CM$	NM$	GM$	Milk	Fat (%)	Fat (lbs)	Pro (%)	Pro (lbs.)	SCS	PL	CCR	HCR
1	350	357	357	333	805	-0.06	15	0	26	3.05	2.5	0.8	0.5
2	212	291	282	265	-482	0.15	22	0.05	0	2.92	2.3	0.6	0.9
3	379	327	335	294	1577	-0.04	50	-0.03	39	3.16	-0.9	-3.3	-0.8
4	-80	7	-2	10	-795	0.09	-6	0.06	-7	3.03	1.5	2.1	1
5	230	262	258	243	383	0.02	20	0.02	17	2.93	2.1	1.9	0.7

Heifer #3 has the highest milk PTA, but her NM$ is lower than heifer #1. Why?

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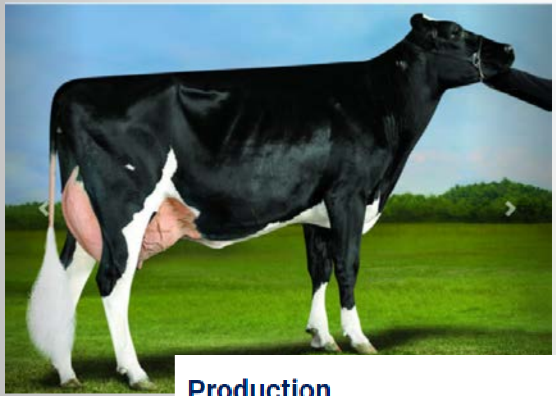
RANK YOUR HEIFERS

Heifer #	Visual Rank	Sire PTA Rank	Sire/MGS PTA rank	Heifer PTA
1				
2				
3				
4				
5				



Bull 1

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Production

Dtrs: 0 Herds: 0 NM$: +1075 TPI®: +2938

Milk	+1084 Lbs	81% Rel
Pro	+60 Lbs	+0.09%
Fat	+112 Lbs	+0.24%
FS	+320 Lbs	
CM$	+1091	
GM$	+1054	
FM$	+946	

Health & Fertility

PL	+4.0	75% Rel
LIV	+2.7	71% Rel
DPR	-0.6	74% Rel
SCS	2.98	77% Rel
HCR	+2.2	72% Rel
CCR	+0.3	74% Rel
AHI	111	
Recessives	HH1T, HH2T, HH3T, HH4T, HH5T, HH6T, TC, TD, TL, TN, TR, TS, TV, TY	

Calving Traits

SCE	1.9%	75% Rel	47 Obs
DCE	1.8%	70% Rel	0 Obs
SSB	6.4%	65% Rel	47 Obs
DSB	3.5%	64% Rel	0 Obs

Conformation

Dtrs: 0 Herds: 0 PTAT Rel: 79%

Bull 2

Production

Dtrs: 0 **Herds:** 0 **NM$:** +1011 **TPI®:** +2898

Milk	+1612 Lbs	79% Rel
Pro	+65 Lbs	+0.05%
Fat	+123 Lbs	+0.21%
FS	-26 Lbs	
CM$	+1023	
GM$	+903	
FM$	+928	

Health & Fertility

PL	+4.8	74% Rel
LIV	+1.2	70% Rel
DPR	-2.5	73% Rel
SCS	2.84	75% Rel
HCR	-2.2	70% Rel
CCR	-1.1	73% Rel
AHI	95	
Recessives	HH1T, HH2T, HH3T, HH4T, HH5T, HH6T, TC, TD, TL, TN, TR, TS, TV, TY	

Calving Traits

SCE	2.1%	61% Rel	0 Obs
DCE	2.2%	57% Rel	0 Obs
SSB	5.5%	57% Rel	0 Obs
DSB	4.8%	54% Rel	0 Obs

MATE YOUR HEIFERS

Heifer #	Heifer strength	Heifer weakness	Sire #	Sire Strength	Sire Weakness
1	FM 805	Fat -0.06	2	FM 1612	HCR -2.2
2	HCR 0.9	FM -482	2	FM 1612	HCR -2.2
3					
4					
5					

Choose mating strategy – How are you choosing the sire for heifer #1?

Heifer #1 Mating heifer strong in FM to sire strong in FM (positive assortative mating)

Heifer #2 mating heifer weak in milk to sire strong in milk (corrective mating)

TOP HEIFERS

Group 19

COMPARISON OF GROUP 19 NM$

Heifer #	S NM$	S+GS NM$	H NM$
1	531	482	340
2	531	453	312
3	531	452	464
4	419	396	74
5	531	398	181
6	531	504	178
7	531	506	505
8	676	676	432
9	177	296	293
10	604	470	-105
11	581	524	201
12	581	512	336
13	581	613	405
14	581	486	114
15	639	512	641
16	639	547	455
17	639	514	516
18	639	625	694
19	639	503	344
20	639	512	609

Heifer #	S Milk	S+GS Milk	H Milk	S Fat (lbs)	S + GS Fat	H Fat
1	1252	1007	791	67	55	36
2	1252	1028	980	67	54	41
3	1252	1140	547	67	60	45
4	650	920	410	71	57	4
5	1252	978	-190	67	48	4
6	1252	1091	-554	67	65	25
7	1252	1171	960	67	54	46
8	1020	913	270	54	71	29
9	356	883	283	35	52	33
10	650	618	-1769	79	56	-25
11	206	640	230	47	40	2
12	206	477	352	47	52	20
13	206	376	512	47	66	22
14	206	381	-39	47	43	-7
15	1206	854	650	60	54	30
16	1206	1143	493	60	64	23
17	1206	1209	430	60	50	29
18	1206	967	868	60	65	61
19	1206	1017	-216	60	45	14
20	1206	854	848	60	54	39

Heifer #	S CM$	S+ GS CM$	H CM$	S Pro (lbs.)	S+GS Pro	H Pro
1	524	482	334	36	32	21
2	524	453	309	36	33	30
3	524	446	463	36	33	21
4	453	420	72	39	40	8
5	524	388	183	36	26	1
6	524	510	187	36	38	-1
7	524	500	499	36	34	25
8	714	712	441	55	49	25
9	175	302	303	13	32	27
10	644	496	-95	41	33	-32
11	626	555	202	33	38	10
12	626	543	336	33	33	13
13	626	654	410	33	35	21
14	626	518	121	33	31	10
15	672	544	654	53	44	37
16	672	573	460	53	48	18
17	672	542	533	53	51	32
18	672	660	711	53	48	46
19	672	518	355	53	36	7
20	672	544	618	53	44	41

Heifer #	S SCS	S+GS SCS	H SCS	S PL	S+GS PL	H PL
1	3.24	3.13	3.20	3.4	3.23	1.10
2	3.24	3.16	3.14	3.4	2.61	1.00
3	3.24	3.14	3.16	3.4	2.28	2.50
4	2.91	2.85	2.96	1	1.12	0.10
5	3.24	3.19	3.10	3.4	2.41	1.80
6	3.24	3.08	2.98	3.4	2.41	1.50
7	3.24	3.16	3.16	3.4	4.22	3.30
8	3.07	2.94	3.05	5.5	4.95	3.00
9	3.19	3.06	3.00	-0.9	-0.43	1.10
10	2.75	2.85	3.12	3.2	2.64	2.90
11	2.9	2.92	3.01	5.1	4.65	2.10
12	2.9	2.92	3.06	5.1	3.20	2.80
13	2.9	2.83	2.91	5.1	4.69	3.10
14	2.9	2.91	2.95	5.1	4.06	1.20
15	2.75	2.84	2.86	6.2	4.16	4.30
16	2.75	2.78	2.82	6.2	4.22	3.80
17	2.75	2.80	2.72	6.2	4.26	4.30
18	2.75	2.81	2.74	6.2	5.02	3.50
19	2.75	2.68	2.81	6.2	4.79	3.60
20	2.75	2.84	2.99	6.2	4.16	3.30

S HCR	S +GS HCR	H HCR
0.9	0.63	0.60
0.9	1.55	0.20
0.9	-0.17	-0.10
-1	-2.01	-1.00
0.9	0.66	0.70
0.9	1.12	1.10
0.9	1.75	2.00
1.2	0.76	0.10
-1.4	-1.88	-1.20
-1.7	-2.21	0.90
2	1.85	0.50
2	1.78	1.00
2	1.29	-0.80
2	2.54	1.30
1	0.03	1.20
1	0.73	-0.30
1	0.66	0.50
1	1.62	-0.40
1	0.92	-0.40
1	0.03	1.20

S CCR	S+GS CCR	H CCR
2.7	1.75	1.20
2.7	3.00	0.80
2.7	1.98	2.00
-3.9	-4.16	-0.30
2.7	2.21	3.10
2.7	1.55	1.40
2.7	2.48	1.50
3.7	2.24	1.30
-3	-3.40	-0.10
0.8	-0.33	3.40
1.9	1.52	0.10
1.9	1.02	1.30
1.9	1.06	-0.20
1.9	1.19	0.80
2.5	1.62	2.90
2.5	1.02	1.90
2.5	1.98	2.00
2.5	2.15	-1.20
2.5	2.34	3.10
2.5	1.62	2.00