



## Prototype Stayability Analysis using Random Regression

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## Stayability

- ▶ Stayability Defined
  - Probability of surviving to a specific age given the opportunity to reach that age.
- ▶ Initial Impetus
  - Cows need to remain in production to generate enough revenue to offset the costs of development and maintenance.
    - 5 calves → 6 years of age
- Herd profitability
  - Cows remaining past their break even age must compensate for those culled.
  - 53 - 77% of the value of maternal indexes

## Stayability Issues

- ▶ Age at which individuals begin to receive observations.
  - Female animals - Observation at 6 years
  - Sires - 8 years for first observation
  - Affects Accuracy → Genetic progress
- How do we get higher accuracy?
  - Correlated traits
    - Measured at earlier ages
    - Phenotypes other than stayability.
  - Use more data

## Simmental Aggregate Stayability

- ▶ Stayability to 6 years of age is heritable.
  - What about 3 year? 4 year? 5 year?
  - Are they heritable?
  - What is their "genetic" relationship to 6 year stayability?

	Stay3	Stay4	Stay5	Stay6
Stay3	<b>0.17</b>	0.79	0.56	0.64
Stay4		<b>0.18</b>	0.67	0.55
Stay5			<b>0.20</b>	0.88
Stay6				<b>0.21</b>

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- ▶ Four separate evaluations
  - Combine ST3, ST4, ST5, ST6 using index techniques into an aggregate ST6 evaluation.
    - Minimum, average, maximum accuracy increase
      - 0.00, 0.07, 0.32

## Stayability to Consecutive Calvings - Random Regression

- ▶ Prototype evaluation for Canadian Simmental
- ▶ Regressed incidence of calf (0 / 1) on age
  - Cow age 3-9
- ▶ Fixed effects
  - Age at first calving
  - Year of birth by birth season interaction
- ▶ Random Regressions (Cubic Polynomial)
  - Additive Genetic (Animal)
  - Contemporary Group
  - Permanent Environment

Jamrozik et al., 2013

### Random Regression

- Predict a regression equation for each animal.
  - $y = \text{Intercept} + \text{Slope} * (\text{Information})$
  - Regression coefficients are predicted for each animal.
    - Predicting an animal's genetic merit over time
- Genetic Evaluation
  - Breeding values for regression parameters
  - Individual animal regression line genetic predictions
    - Allows for a genetic prediction for any endpoint in the data range.



### Heritabilities and Genetic Correlations

Coefficient	Intercept	Linear	Quadratic	Cubic
Intercept	<b>0.24</b>	-0.67	-0.23	0.03
Linear	0.02	<b>0.16</b>	-0.31	-0.09
Quadratic	-0.63	0.01	<b>0.06</b>	-0.27
Cubic	0.14	-0.56	-0.24	<b>0.06</b>

Heritability - On the diagonal  
 Genetic Correlation - Above the diagonal  
 Permanent Environmental Correlation - Below the diagonal

Jamrozik et al., 2013

### Heritabilities and Genetic Correlations – Observed

Cow Age	3	4	5	6	7	8	9
3	<b>0.36</b>	0.96	0.89	0.83	0.77	0.71	0.61
4	0.84	<b>0.23</b>	0.98	0.94	0.87	0.81	0.74
5	0.67	0.96	<b>0.19</b>	0.98	0.94	0.89	0.81
6	0.56	0.87	0.97	<b>0.16</b>	0.98	0.95	0.86
7	0.47	0.71	0.85	0.96	<b>0.15</b>	0.99	0.89
8	0.40	0.55	0.69	0.85	0.96	<b>0.13</b>	0.94
9	0.31	0.44	0.53	0.64	0.75	0.88	<b>0.12</b>

Heritability – On the diagonal  
 Genetic Correlation – Above the diagonal  
 Phenotypic Correlation – Below the diagonal

Jamrozik et al., 2013

- ### American Simmental
- Observations – 0 / 1
    - Presence or absence of calf at ages 3 through 6 given a calf at 2.
  - Fixed Effects
    - Age at calving
    - Year of Birth
  - Linear Random Regression (Intercept & Slope)
    - Additive Genetic (Animal)
    - Contemporary Group
    - Permanent Environment
  - Simplified regression order

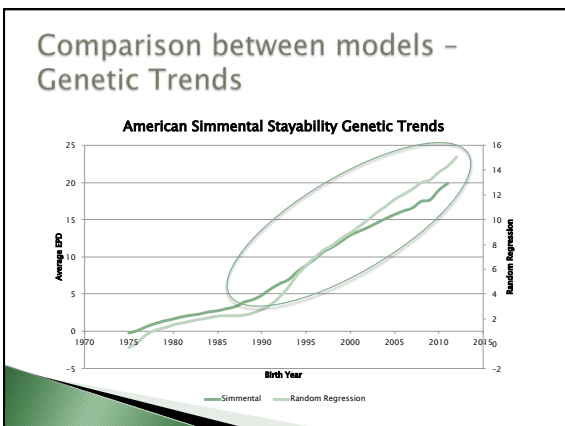
- ### American Simmental
- Predictions
    - EBV / EPD for Intercept and Slope from the regression of calf presence on age.
- Stay EBV = Intercept EBV + Slope(EBV) \* Age
- Observed EPD – Genetic influence on having a calf at a specific age given a calf at 2
    - 3, 4, 5 and 6 years of age
    - Summed to get genetic influence of having 5 calves by 6 years of age

### Comparison between models

EPD Correlations: **0.85**

Cow Age	3	4	5	6
3		0.79	0.56	0.64
4	0.96		0.67	0.55
5	0.89	0.98		0.88
6	0.83	0.94	0.98	

Aggregate Genetic Correlation – Above the diagonal  
 Random Regression Genetic Correlation – Below the diagonal



- ### Conclusions
- Random Regression and Aggregate models producing similar results
  - Random Regression models more robust
    - Greater data usage
    - Prediction to any age endpoint
    - Better accounting for non-genetic factors
    - More informative data usage
      - Stayability Endpoint → 2 3 4 5 6
      - Successful 6 year stay → 1 1 1 1 1
      - Unsuccessful → 1 0 0