Precision Matching of Objectives and Technologies in the Implementation of Breeding Programs

Brian Kinghorn\textsuperscript{1,2} and Sandy Kinghorn\textsuperscript{2}

\textsuperscript{1} University of New England, Australia
\textsuperscript{2} MateSel, Australia
We need *precision* in these key questions ...

- Where to go? ... Objectives
- How to get there? ... Technologies

- How to get back?
Where to go

Just one example
Where to go

Just one example
Where to go

Just one example
Animal Breeding questions ... 

- **Where to go?** Explore different directions – different emphasis on each trait or genetic marker, different emphasis on diversity/inbreeding, different patterns of mating constraints, different patterns of use of AI & IVF, etc.

- **How to get there?** Be precise – use all available information on EBVs/EPDs, genomic/pedigree relationships, animal locations, logistical constraints, costs etc. in a balanced manner to best target the chosen direction.
1. The breeder should have ‘ownership’ of the result. This brings relevance.
   – A fancy computer tool is of little value if it is not relevant to the needs of the breeder.

2. The breeder needs power to target a wide range of possible outcomes.
   – As simple as possible
   – As complex as necessary
Example illustrations of MateSel features

Basic operations: Single-sire mating vs. Multi-sire mating

Single-sire matings. You can dictate the range in number of females per bull

Multi-sire mating groups. Male syndicate groups only shown in this screenshot.
Balance strategy: 3. Hard constraint on Target Degrees
Max permissible coancestry: 0.0525
Target Degrees: 0
Weight on progeny F: 0

<table>
<thead>
<tr>
<th>Females</th>
<th>Index</th>
<th>CoanCand</th>
<th>CoanSel</th>
<th>GrandSire</th>
<th>AbsMin</th>
<th>Min</th>
<th>Max</th>
<th>&lt;Uses</th>
</tr>
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<tbody>
<tr>
<td>Magnus</td>
<td>110.62</td>
<td>0.0864</td>
<td>0.1757</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Wayne</td>
<td>114.66</td>
<td>0.0241</td>
<td>0.1469</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

Show matings: Show sire use: Update
Mixed Mating Groups

Multi-sire joining
Multi-sire pastures
Sire syndicates

Preparing matched groups for later matings
Multipliers herds
Groups of AI sires

Mass spawning fish
Open pollination
Groups of AI sires

Thank you Alison!
### Females in Mixed Mating Groups

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Degree 1</th>
<th>Degree 2</th>
<th>Degree 3</th>
<th>Degree 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Carolyn</td>
<td>95.720</td>
<td>0.792</td>
<td>106.999</td>
<td>25.674</td>
</tr>
<tr>
<td>2</td>
<td>Simone</td>
<td>112.840</td>
<td>0.972</td>
<td>97.294</td>
<td>36.363</td>
</tr>
<tr>
<td>3</td>
<td>Jaylee</td>
<td>106.820</td>
<td>1.241</td>
<td>110.051</td>
<td>39.824</td>
</tr>
<tr>
<td>4</td>
<td>Estrella</td>
<td>99.320</td>
<td>0.948</td>
<td>91.881</td>
<td>31.830</td>
</tr>
<tr>
<td>5</td>
<td>Selene</td>
<td>103.960</td>
<td>0.987</td>
<td>112.662</td>
<td>34.859</td>
</tr>
<tr>
<td>6</td>
<td>Danica</td>
<td>100.960</td>
<td>0.648</td>
<td>114.126</td>
<td>28.596</td>
</tr>
<tr>
<td>7</td>
<td>Baylee</td>
<td>102.300</td>
<td>1.125</td>
<td>98.378</td>
<td>32.501</td>
</tr>
<tr>
<td>8</td>
<td>Kallie</td>
<td>91.420</td>
<td>1.081</td>
<td>117.757</td>
<td>28.799</td>
</tr>
<tr>
<td>9</td>
<td>Lina</td>
<td>99.200</td>
<td>0.946</td>
<td>99.768</td>
<td>37.094</td>
</tr>
<tr>
<td>10</td>
<td>Guadalupe</td>
<td>101.240</td>
<td>1.224</td>
<td>84.665</td>
<td>33.386</td>
</tr>
</tbody>
</table>

- **MMG gap**: 0.039
- **Progeny Index**: 103
- **Parental Coancestry**: 0.0525
- **Target Degrees**: 25
- **Weight on progeny F**: 0.0
Balancing long-term and short-term genetic gains

For a closed breeding program, ‘pedal to the metal’ is not best in the long run.
Exploiting prevailing opportunities

Managing the full life cycle. As explained here.
Balance in use and costs of AI and IVF
Targeting Multiple EndUses to cater for the varied needs of bull-buying clients

Female selections

Predicted progeny merit

Female EPDs plotted for two client indices with EndUse 2 and 3 targeted matings in orange and blue.

Useful separation in resulting progeny merit. Example nucleus matings are black, as seen here. Thanks to ABS Global.
Managing distribution of Progeny Inbreeding

When the red line is invoked, HS and FS matings will be quickly eliminated!

This should **not** replace a general weighting against mean Progeny Inbreeding.

https://doi.org/10.1093/jhered/esad027
An efficient approach to using High Calving-Ease bulls

The conventional use of Grouping to allow heifers to be mated only by High CE bulls.

CEcontrol makes better use of the CE EPD resources available, as seen here.

The conventional use of Grouping to allow heifers to be mated only by High CE bulls.

CEcontrol makes better use of the CE EPD resources available, as seen here.
Other issues can be handled, e.g.:

- Management of **distribution of sires across herds**
  - sire referencing schemes
  - genomic reference populations

- Managing **backup sires**

- Creating harmonious **multi-sire mating syndicates**
Other issues can be handled, e.g.:

- Collective **management of multiple genetic markers** (recessive lethals, gene edits, QTL, etc) for both short-term and long-term objectives.

- Decisions on **generation and use of sexed semen** and embryos

- Genomic mate selection.
Bringing MateSel to Beef Breeders

• Why do we have **300 sheep breeders** using MateSel, but probably under **100 beef breeders**?

• … the sheep breeders have a **system to extract the data**.

• The **breeders can operate independently**.

• We are now developing **MSaaS** (MateSel-as-a-Service) to make this available to other service providers: sheepgenetics.org.au/resources/matesel/
Bringing MateSel to Beef Breeders

Breeders extracting data from their association database and configuring initial constraints
Bringing MateSel to Beef Breeders

Breeders reviewing their inputs before launching MateSel

New MateSel Run

Select Herd  ✔  Grouping Rules  ✔  Balance Strategy  ✔  Traits  ✔

You need **250 matings** from **30 male candidates** and **300 female candidates** across **2 male groups** and **4 female groups**.

You are strongly favouring Terminal $Index$ genetic gain over genetic diversity with **10 target degrees**. Your breed society recommends between **10 and 25 target degrees**.

You have placed the following additional trait constraints:

- **Carcass Eye Muscle** target progeny mean of 7.021 (Minimal emphasis)
- **Carcass Fat Depth** target progeny mean of 2.2 (Strong emphasis)

Please provide a short description for this run before launching:

June Joinings
Bringing MateSel to Beef Breeders

MateSel running with the ability to change targets in real-time to test different directions.
Conclusion: The wide value of Precision

• A system that brings precision in predicting the impact of your decisions ...

• ... can also bring power to discover a wide range of alternative directions.

• This gives more control and confidence in chosen directions.
Where to go

How to get back?
Use a dummy individual to represent a large group

<table>
<thead>
<tr>
<th>George</th>
<th>Mildred</th>
<th>Gabrielle</th>
<th>Females in Region 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>George</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mildred</td>
<td>0</td>
<td>1.02</td>
<td>0</td>
</tr>
<tr>
<td>Gabrielle</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Females in Region 6</td>
<td>0.012</td>
<td>0.043</td>
<td>0.131</td>
</tr>
</tbody>
</table>

Average relationship between George and Females in Region 6

Or eg.
- “All sows in multiplier herd 4”
- “All 5 year old cows in Devon”
- “Bulls in syndicate mating group 2”

No pedigree available? See manual for a geneflow solution.

Or use Committed Matings
Bringing MateSel to Beef Breeders

- Which buttons to press
- Demonstrations
- Discussions around opportunities

Manual = 133 pages ... videos popular!
Fine control of trait and marker outcomes

Bimodality in IMF to target two markets

Planned reduction in disease susceptibility

Decreasing expression of a genetic defect to zero

... while increasing the good allele frequency