Economic Analysis of Breeding Programs in Competitive Markets
Impact on Market Share
Jack Dekkers

Evaluating returns from breeding programs:
1. Based on extra profit at the commercial production level – based on GeneFlow methods.
2. Based on evaluating impact on market share and sale of breeding stock.
   - More relevant for programs that operate in a competitive market environment.

A Competitive Global Dairy AI Industry

- global competition for germplasm from progeny-tested bulls
- competition for contracting bull dams
- all competitors have access to semen from all progeny-tested sires for use as bull sires.

Impact of Improving Rate of Response by Firm A in a Competitive Market

- an AI firm’s program is part of a single global breeding program.
- at equilibrium, all AI firms improve at the same rate but with genetic lags.

Breeding Company View of AI Progeny Testing Programs

Based on these considerations, commercial breeding firms must look at breeding programs from a different perspective.
Returns generated by sale of germplasm from marketable bulls

Determined by:
- # marketable bulls
- Ranking of marketable bulls
  → # doses sold
  → $/dose sold

Three ways to increase Market Share

1. Progeny test more bulls
2. Increase # daughters/bull
3. Increase average merit of tested bulls

Example of Economic Optimization of Progeny Group Size in Dairy Cattle

Dekkers, VanderVoort and Burnside
1995, J. Dairy Sci. 79:2056-2070

Optimal combination of # bulls to sample and # daughters tested per bull for a fixed testing capacity?
= total # young bull daughters

Based on Stochastic Simulation of 3 competing AI firms
Base program: each AI firm tests 60 bulls/yr
with 60 daughters/bull

Maximizing Genetic Gain in the Population
Based on collective effect of all three firms

Figure 8.10. Effect of progeny group size and number of bulls sampled on genetic gain for three test capacities

Optimal progeny group size:
- ~50 based on detem. model
- ~60 based on stoch. model
But very robust
**Market Share with Fixed Test Capacity**

For an AI firm that changes its program while the other two firms maintain the base program (60/60):

- To maximize # marketable bulls: sample more bulls with smaller progeny group size.

**Maximizing Net Returns from Semen Sales**

Costs = (# bulls tested) x (Fixed costs/bull) + (test capacity) x (cost/daughter)

- To maximize net returns: sample fewer bulls with larger progeny group size (~100).

**Three ways to increase Market Share**

1. **Progeny test more bulls**
2. **Increase # daughters/bull**
3. **Increase average merit of tested bulls**

**Sensitivity Analysis of Optimal progeny group size for fixed test capacity**

<table>
<thead>
<tr>
<th>Test Capacity</th>
<th>2700</th>
<th>3600</th>
<th>4500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deviation from base</td>
<td>$20</td>
<td>$30</td>
<td>$20</td>
</tr>
<tr>
<td>None</td>
<td>96</td>
<td>102</td>
<td>97</td>
</tr>
<tr>
<td>Linear price function</td>
<td>92</td>
<td>97</td>
<td>91</td>
</tr>
<tr>
<td>Population size = 20%</td>
<td>96</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td>Population size = 20%</td>
<td>100</td>
<td>104</td>
<td>100</td>
</tr>
<tr>
<td>Semen price = 20%</td>
<td>97</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td>Semen price = 20%</td>
<td>100</td>
<td>104</td>
<td>100</td>
</tr>
<tr>
<td>Interest 8%</td>
<td>100</td>
<td>104</td>
<td>99</td>
</tr>
<tr>
<td>One competitor at 100</td>
<td>99</td>
<td>102</td>
<td>99</td>
</tr>
</tbody>
</table>

- Extra profit (x10 $/yr) at optimum versus at 60 daughters/bull:
  - None: $49, $66, $49, $73, $56, $66
  - Linear semen price: $28, $44, $26, $50, $34, $61
  - One competitor at 100: $54, $72, $56, $60, $61, $92

- Shadow value of test capacity ($/daughter):
  - None: $375, $274, $335, $236, $285, $135
  - Linear semen price: $397, $287, $352, $246, $305, $207
  - Population size = 20%: $444, $346, $416, $313, $377, $278
  - Population size = 20%: $299, $181, $229, $134, $200, $159
  - Semen price = 20%: $495, $389, $448, $344, $398, $300
  - Semen price = 20%: $259, $181, $229, $134, $200, $159
  - Interest 8%: $262, $183, $251, $155, $219, $126
  - One competitor at 100: $323, $235, $355, $255, $300, $201

- Progeny group size is 3600. semen price is based on quadratic function of estimated breeding value (EBV). Interest rate is 8%.
Increasing Market Share by improving Average Genetic Merit of Young Bulls entered into Progeny Testing Program

1. Increase genetic merit of bull sires and bull dams
2. Pre-selection of young bulls based on markers or GEBV

Deterministic modeling of the effect of pre-selection on market share

This can be modeled using Multrunc.xls

Exercise

Use Multrunc.xls to evaluate the impact of pre-selection of young bulls based on GEBV on # marketable progeny-tested bulls

Assumptions:
- Selection is for total merit with $h^2 = 0.3$ and $s_g = 10$
- Competitors and your company have equal access to the same groups of bull dams and bull sires.
- Competitors jointly test 200 bulls without pre-selection and 60 dams/bull
- Your company tests 100 bulls with pre-selection and 60 dams/bull
  - Pre-selection is based on selecting the best 100 out of 200 calves based on a GEBV with accuracy = 0.4
  - The top 30 bulls based on their progeny test EBV (based on 60 daughters only) are marketable
- GEBV or pedigree do not contribute to progeny test EBV