Gene 422/522

Design of breeding programs

University of New England, Armidale.
Animal Breeding ...

Objectives to target

Where to go?

Tools to exploit

How to get there?

Strategies to adopt
Animal Breeding in a nutshell

Where to Go

How to get there

Breeding objectives

Trait measurement
- Which traits
- Which animals
- Males / females
- Progeny test
- Nucleus / commercial
--Genotypings

Estimation of breeding value
- Phenotypes
- Pedigree
- BLUP
- Genetic Markers

Reproductive technology
- Artificial Insemination
- MOET
- JIVET
- Cloning

Selection, culling & Mating
- Index / EBV’s
- Balancing merit and inbreeding
- Other issues
Why do we need a design?

- **Genetic Improvement**
  - Which animals to measure
  - Where to select them
  - Mating strategy $\rightarrow$ best to best

- **Dissemination of Genetic Superiority**
Design examples

• One-tier breeding program

Select and replace

Breeding males

Breeding females

Select and Replace

Male progeny

Female progeny
Design examples

- Two-tier breeding program
Design examples

• 3-tier breeding program
Design examples

- Two-tier breeding program

Nucleus can be Central or Dispersed
Centralized:

- More uniform testing
- Easier to apply MOET

Centralized Nucleus
• Central Nucleus

Nucleus: could be defined as
"the mothers and fathers of the future bulls"

4 pathways:
- selection of sires for sires
- sires for cows
- dams for sires
- dams for cows
• Dispersed Nucleus

Nucleus: could be defined as
"the mothers and fathers of the future bulls"
Local ‘nucleus’ can in fact be multiplier

Other Nucleus (USA)

Genetic lag

Nucleus

Genetic improvement

dissemination

Commercial producers
Closed nucleus breeding schemes

1. Selection only permanently effective in nucleus.

2. Nucleus objectives impact on whole scheme.

3. Lag …

4. Common in pigs and poultry
Closed nucleus breeding schemes

- Genetic merit
- Nucleus flock
- Base flocks
- 2 generation lag
- Start selection in base
- Maintain selection in base
- Stop selection in base
More genetic improvement (about 15%)

Data collection (records/pedigree) also needed in base but usually more intensive in nucleus
Open nucleus systems

• Select the best animals from lower tiers to compare for being nucleus parents

• degree of ‘openness depends on
  ▪ difference between nucleus and commercial
  ▪ spread of their breeding values

• other nuclei
• Common in dairy
Open nucleus breeding schemes

- More information in nucleus
  - more spread of values
  - more selected from nucleus
Implementation of programs ...

• **Rules-based approach:**
  – “Start joining on 1st February”
  – “Use best 10 rams mated to best 400 ewes”
  – “Set up a rotational cross”

• **Tactical approach**
  – Maximise impact of selection and mating, based on *prevailing* animals, markets, costs, constraints and opportunities.
Rules-based approach to Design

Targets

Data

Parameters

Decision Support System

Sets of Rules

Use this breed
Select on EBV
Age at culling
Connect herds
…etc.

ACTIONS
Tactical approach to Design
Action Decision Systems

TGRM

Current Targets
Current Data
Current Parameters
Current Opportunities
Judgement
Possible outcomes

ACTIONS

TGRM will come later !!
Tactical approach to Design

• Determine the consequences of your actions (or … develop an objective function which describes net utility as a function of selections and mate allocations).
  – eg. Predicted merit one generation ahead
  – eg. Predicted merit \( n \) generations ahead

• Find the actions which maximise the consequences (or … develop and implement a mate selection algorithm which maximises this objective function).
  – egs. linear programming and genetic algorithms
## Dairy breeding structure

<table>
<thead>
<tr>
<th>Elite matings:</th>
<th>males</th>
<th>x</th>
<th>females</th>
</tr>
</thead>
<tbody>
<tr>
<td>to breed males</td>
<td></td>
<td></td>
<td>to breed males</td>
</tr>
<tr>
<td></td>
<td>[ mm</td>
<td>x</td>
<td>fm ]</td>
</tr>
<tr>
<td>Normal matings:</td>
<td>males</td>
<td>x</td>
<td>females</td>
</tr>
<tr>
<td>to breed females</td>
<td></td>
<td></td>
<td>to breed females</td>
</tr>
</tbody>
</table>
|               | [ mf | x | ff ] |... maybe 10,000 cows
|               |       |   | ... maybe 10,000,000 cows |
Dairy breeding structure

<table>
<thead>
<tr>
<th>ELITE MATINGS</th>
<th>mm: 2 to 5 top progeny tested sires.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fm: best cows selected on index, contract mated with mm semen to produce young bulls for progeny testing.</td>
</tr>
<tr>
<td>NORMAL MATINGS</td>
<td>mf: second best (but acceptable) progeny tested sires, plus young bulls for progeny testing.</td>
</tr>
<tr>
<td></td>
<td>ff: ordinary cows, used for ordinary matings plus progeny testing.</td>
</tr>
</tbody>
</table>
Dairy structure is a geographically diffused open nucleus structure …