Structure of Breeding Programs

Lecture 16
Introduction to Breeding and Genetics
GENE 251/351
School of Environment and Rural Science (Genetics)
Animal Breeding in a nutshell

Where to Go

Breeding objectives

How to get there

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 → best to best

- Dissemination of Genetic Superiority

- Inbreeding
Design Examples

- One-tier breeding program

Select and replace

Breeding males (few)

Breeding females (many)

Select and Replace

Male progeny

Female progeny
Design Examples

Two-tier breeding program

- Genetic lag
- Breeding rams
- Commercial producers
- Nucleus
- Genetie improvement
- Measurement
- Dissemination
Genetic merit of nucleus versus base

- Genetic merit
- Nucleus flock
- Base flocks
- 2 generation lag
- Start selection in base
- Maintain selection in base
- Stop selection in base
Design Examples

3-tier breeding program

- **Nucleus**: 100k ewes
- **Multipliers**: 1 million ewes
- **Commercial producers**: 10 million ewes

Genetic improvement and measurement:

- Breeding rams
3-tier breeding program

Design Examples

- Nucleus
- Multipliers
- Commercial producers

Genetic improvement
Genetic measurement
dissemination
dissemination

Genetic lag
Design Examples

Two-tier breeding program

Central Nucleus
(pigs, poultry, some dairy)

or Dispersed
(sheep, cattle)
Nucleus: could be defined as "the mothers and fathers of the future bulls"

What defines the nucleus?

4 pathways:
- selection of sires for sires
- dams for sires
- top AI sires
- bull dams

Elite matings:
- sires for cows
- average AI sires
- normal cows

Normal matings:
- dams for cows

Nucleus

Commercial producers
Centralized Nucleus

- More uniform testing
- Easier to apply MOET

Centralized Nucleus
Nucleus: could be defined as

"the mothers and fathers of the future bulls"

dispersed nucleus

- **Top studs**: Delivering the genetics of the future bulls
- **Other studs**: Acquire their genetic from top studs, themselves being merely multipliers
Local ‘nucleus’ can in fact be a multiplier.

Examples: Angus Australia breeding program, Holstein Australia Breeding program.
Nucleus Breeding Schemes

Closed Nucleus

Replacement animals for nucleus only from nucleus

Selection only permanently effective in nucleus.

Nucleus objectives impact on whole scheme.

Common in pigs and poultry
Open Nucleus

Replacement animals for nucleus but also some from base

Selecting from base requires measurement in base

More genetic improvement than closed scheme (~15%)

Common in dairy
Closed nucleus breeding schemes

Any selection at the base has limited effect and is temporarily...
Open nucleus systems

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

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

• Open to nuclei
Open Nucleus

Difference in genetic mean between nucleus and base (~2 generations)

Truncation Point

Elite matings
- 80% from nucleus
- 20% from base
Open Nucleus

Difference in genetic mean between nucleus and base (~2 generations)

Truncation Point

Elite matings
70% from nucleus
30% from base

More measurement in base, more spread of EBV, more selected from base
A genetic evaluation system helps to design breeding programs - it optimizes use of old versus young bulls

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Select on phenotype

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Select on EBV
Why need a design?

• Genetic improvement

Need decisions on

- which animals to measure or genotype \textit{nucleus males (females)}
- where to select them \textit{nucleus/base}
- mating strategy \textit{best to best} $\rightarrow$ elite matings

• Dissemination of genetic superiority
  - Often a challenge when setting up a new program, esp in developing countries.
  - How to sell/give improved seedstock to local farmers

• Inbreeding
Summarizing practical and logistical issues related to optimal design of breeding programs

- Increase in genetic merit
  - Select as few as possible
  - Select across ages
  - Purchase/Import semen?

- Inbreeding
  - ...but select not too few

- Crossbreeding
  - Exploit this?

- Breeding objective

- Connections
  - Make linkages across herds

- Measurement strategies
  - Measuring expensive traits, DNA testing

- Reproduction technology
  - Apply MOET to top females? Use of AI

- Running Cost
  - How many mating paddocks?

- Other issues