Exercises Day 3

Part 1   Inbreeding, Optimal Contribution Selection

Exercise 1.1 Inbreeding

Run *SelAction* – discrete generations – 1-stage selection and load 'Day 3 Inbreeding prediction'.

The base scenario is selection for a single trait with heritability = 0.2 based on own performance alone. The number of males selected = 20; the number of females selected = 100; the proportion of males selected = 0.05; the proportion of females selected = 0.25.

Evaluate the impact of the following factors on genetic gain and inbreeding (make a table to keep track of the scenarios you evaluate and enter genetic gain and inbreeding. For each scenario, try to explain the trends in inbreeding and gain you see. At the start of each scenario, go back to the base situation (e.g. by uploading the file again, without saving).

a.   Heritability of the trait – change the heritability of the trait, keeping everything else constant; evaluate heritabilities ranging from 0.01 to 0.99.

b.   Population size – change the numbers of males selected from 20 to 5 to 50, keeping the proportion selected constant.

c.   Population size – change the numbers of females selected from 100 to 50 to 200, keeping the proportion selected constant.

d.   Proportions selected – keep the numbers of males and females selected constant at 20 and 100 but change the proportions of males and females selected (evaluate each separately)

e.   Inclusion of family information in the indexes used for selection; starting with adding BLUP EBV of the parents, then FS info, then HS info, and finally progeny information.

f.   Repeat e. but now for a scenario where males have no own performance – so under the 'Index' tab, select 'Use different indexes for males and females' and remove OP for males.

g.   Investigate any other scenarios you think might be instructive.
-

Exercise 1.2 Optimal Contributions Selection

The exercise demonstrates the idea of balancing selection and long-term inbreeding in an index of genetic merit and parental co-ancestry.

Use the *xGxAx.xls* program.

This allows you to optimally select from 4 males and 4 females. The X-matrix contains the 'optimal contributions', i.e. the proportion of genes in the next generation that will be contributed by this parent.

Notice that the contributions of males sum to 0.5, and similarly for females. Notice that some males and females are genetically superior to the competitors. With no relationships among the four candidates, matrix A is the identity matrix. The criterion (Crit) for judging this solution is equal to $x'G + \lambda x'Ax$. Be sure that you understand this before continuing.

For a give dataset (i.e. Index values in G and Additive genetic relationships in the Relationships matrix), you can find optimal contributions for a single lambda (λ) value. Lambda is the penalty on inbreeding. You can also draw the graph, which loops through all lambda values between 0 and - (a big number). A graph will be different each time you change values in either breeding values or relationships among candidates.

Put all relationships to 0, and find optimal contributions for $\lambda = 0$ and $\lambda = -9999$.

Before clicking the 'optimal contributions' button, try to predict them by reasoning, and subsequently check them by the program.

Change the relationships by making the two best males full sibs.

1. Why does the graph change (after clicking 'draw graph')?

2. Predict and find optimal contributions for $\lambda = 0$ and $\lambda = -9999$.

3. For 2) and 3) make a note of dF and dG.

4. Find a best value for λ (i.e "what's your favourite point on the graph?")

Answer questions 1-4 after changing more relationships by also making the two best females full sibs.

Exercise 1.3   Breeding Program design

Exercise 1.3.1   Open Nucleus Schemes

Use *truncsel.xls* to work out the degree of openness of a nucleus breeding scheme.

Imagine a herd with 400 breeding females, breeding bulls for about 15,000 cows in the second tier (is this feasible?). IN the 'optimize age structure in a herd'-sheet, you can verify that the herd needs around 8 male and 140 females replacements per year.

Now use the 'optimize selection across age classes' sheet to work out the degree of openness. Use two classes, one for the nucleus and one for the second tier. Make assumptions for each class about
1) the number of selection candidates
2) the SD, i.e. accuracy/, of the EBV / selection criterion)
3) the difference in mean between the two tiers.

Now based on these assumptions, work out the optimal number selected across these tiers, first for males and then for females. Also, estimate the extra gain that can be achieved by a certain level of trait recording in the commercial tier.

Exercise 1.3.2   Effect of reproductive technologies

Still using the same seedstock herd with 400 breeding females, and the 'optimize age structure in a herd'-sheet in *truncsel*, look at options to boost reproductive rates (Look at MOET and JIVET) and give an estimate of how much extra genetic gain this could give.

Are these reasonable prediction of the effect of such technologies? What are the shortcomings of a simple modeling via this *truncsel* program?

Part 2: Optimizing Breeding Programs, Optimizing measurement

Exercise 2.1 Optimizing breeding Programs

Imagine a breeding program for beef cattle. You can use *truncsel.xls* ('optimize age structure in a herd'-sheet) to estimate the amount of genetic gain that can be achieved per year.
The a breeder decides to select on an index that aims for a specified objective (e.g. the Japanese export market, with a standard deviation of the breeding objective of $20.

The accuracy of bulls' EBVs for the selection index increases with age as follows;

Age:	1	2	3	4	5
Male Accuracy	0.35	0.45	0.78	0.80	0.82
Female Accuracy	0.35	0.45	0.52	0.54	0.55

Assume a breeding program where the breeder has a closed stud (nucleus) of 400 breeding females. The weaning rate is 1. He mates 40 cows per bull annually. The age structure of the cows is such that of all cows mated annually, the distribution over age classes 2, 3, 4, and 5 is 40%, 30%, 20% and 10%, respectively.

- Predict the annual rate of genetic gain if bulls are used only once (progeny dropped when age of sire is 2 yrs) and females are selected as heifers and drop their first calves at 2 years. After 2 years, some cows are culled at random.
- Answer question 2, but now assuming bulls are used only once and the first time at the age of 4 years, after being progeny tested.
- Predict (calculate) the annual response when selection is optimized across age classes.
- One important trait in the index is marbling, which is not directly measured. What would happen to the rate of genetic gain, and the underlying components such as age structure) if we had genomic selection in place? Assume that the accuracy of selection improves as follows

Age:	1	2	3	4	5
Male Accuracy	0.50	0.55	0.80	0.81	0.83
Female Accuracy	0.50	0.55	0.58	0.58	0.58

Exercise 2.2 Economic Evaluation of Breeding Programs

The bulls from the stud in Exercise 2 that are sold to the commercial farmer have on average 150 progeny of 3 years that they are used (weaning rate 100%, mated to 50 dams). Work out the size of the commercial population that can be served by this stud.

Make a prediction of the net present value of the genetic gain due genetic improvement in this flock (for the case without genomic selection.
How much can the flock afford to invest in genetic improvement to at least break even on its breeding effort.
How much can the flock afford to invest in genomic selection.
What if only bulls were genotyped?

Optional

Use the *gflow.xls* sheet to determine the GFLOW of improved genetic material from the stud to the commercial tier.
What is the value of one unit of difference in EBV between two stud bulls?
What is this value for a difference between two bulls sold to the commercial tier?