Chapter 8.9: Examples of estimating breeding values

First back to estimating breeding values. Remember: for estimating breeding values we needed the regression coefficient, but also the phenotypic superiority. So how do we obtain that if we have information on more than just a single animal? Fortunately that is simple: just take the average. For example, if you want to estimate the breeding value for a sire with 20 offspring based on the offspring performance, then you take the average of the performance of the offspring and relate that to the population average. If the offspring average is 50 and the population average is 40, then

\[(P_{\text{offspring}} - \bar{P}) = 50 - 40 = 10\]

Next step is to combine the regression coefficient and the phenotypic superiority so that we can estimate the breeding value. Remember the basic principle:

\[\text{EBV} = b \times (P - \bar{P})\]

There are always three steps you need to take to estimate the breeding value of an animal:

1. determine the phenotypic superiority of your information source
2. determine the regression coefficient
3. combine the previous two to estimate the breeding value

Below you will find some examples on how to apply this in practice.

Examples:

1. What is the EBV for a stallion with excellent parents?

The heritability for rideability in riding horses is 0.29. The sire of this stallion scored 9.5 for rideability, and the dam scored 9.0. The population average is 7.0

Step 1: the phenotypic superiority equals the parent average, which is \((9.5+9.0)/2 – 7.0 = 2.25\)

Step 2: the regression coefficient for mid-parent information is \(b = h^2 = 0.29\)

Step 3: the EBV = \(0.29 \times 2.25 = 0.65\)

2. What is the EBV for milk production of a dairy bull with 100 daughters (half-sisters)?

The heritability for milk production is 0.3. The daughters produce on average 10,000 kg, and the population average is 9,500 kg.

Step 1: the phenotype superiority = 10,000 – 9,500 = 500 kg.

Step 2: the regression coefficient (see formula for offspring information in table 1)

\[b = \frac{\frac{1}{2} \frac{n}{h^2}}{\frac{1}{4} (n-1) h^2} = \frac{\frac{1}{2} \times 100 \times 0.3}{1+ \frac{1}{4} \times 100 \times 0.3} = 15 / 8.425 = 1.78.\]

Step 3: the EBV for milk production of this bull is 1.78 \(\times\) 500 = 890 kg.

Note: the maximum regression coefficient of a single parent (usually sire) on offspring is 2 because the sire passes half its genome on to the offspring. Turning that around, and assuming that the sire is mated to average dams, if you have information on the superiority of the offspring than that of the sire is that of the offspring times 2.

Thus:

The maximum regression coefficient when using offspring information is 2, and not 1

3. What is the EBV for average daily gain while growing from 25 to 100 kg of a pig with information on 20 full sibs, but no own performance?

The heritability for slaughter weight is 0.4, the population average is 875 g/d, and that of the 20 full sibs is 920 g/d. The common environmental effect for full sibs \(\left(\sigma_e^2\right) = 0.45\)

\[\sigma_e^2 = \left(\frac{1}{2} \times 20 \times 0.45\right) = 9.00\]

\[\frac{\sigma_e^2}{\sigma^2} = \frac{9.00}{0.45} = 20\]

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\[\frac{b}{h^2} = \frac{20}{0.45} = 44.44\]

\[b = \frac{44.44 \times 0.4}{1 + \frac{44.44 \times (20-1) \times 0.4}{0.45}} = \frac{18.00}{1 + 15.82 = 1.81}\]

Step 3: the EBV for average daily gain of a pig is 1.81 \(\times\) 920 = 1,690.8 g/d.
Step 1: the phenotypic superiority = 900 – 875 = 25 g/d

Step 2: the regression coefficient = (½ * 20 * 0.4)/(1+(20-1) * (½ * 0.4 + 0.45)) = 4/13.35 = 0.30

Step 3: the EBV for average daily gain from 25 to 100 kg for this pig is 25 * 0.3 = 7.5 g/d.

Note: the regression coefficient is lower than the heritability. Reason is that full sibs perform more alike because they have shared a common environment. Therefore, a smaller proportion of the phenotypic superiority can be assigned to shared genetics than without shared common environment. This is taken into account through the $c^2$ when determining the regression coefficient for estimating the breeding value.

Thus:

The presence of a common environmental effect has a reducing effect on the estimated breeding value.