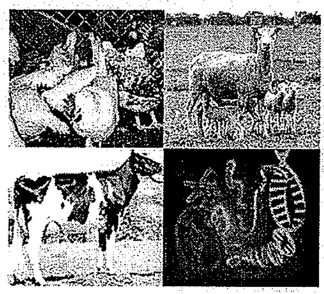
Properties of estimating breeding values



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Estimating BVs

$EBV = h^2P$

- P is own phenotype, h^2 is heritability or an index weight on own phenotype
- for within flock selection on a single trait, ranking is the same as P

$EBV = b_1P_1 + b_2P_2 + b_3P_3 + ...$

- P is an information source, e.g. own phenotype, information from relatives, correlated traits
- b is the index weight

Properties of BVs

Information sources

There can be many information sources

- own performance
- mean performance of full sibs
- mean performance of half sibs
- performance of sire and / or dam
- performance of progeny

$$EBV = b_1P + b_2P_2 + b_3P_3 + \dots\dots\dots b_nP_n$$

To ensure fair comparison

Compare only to contemporary group

- A contemporary group is generally defined as animals raised under similar conditions (born within the same year and season), the same sex, and with small age differences

Adjust data for fixed effects

- Examples of fixed effects: sex, birth-type, year, age

Comparison to contemporary group

	Single	Twins	
Males	60 Kg	55 Kg	*57.5 Kg*
Females	50 Kg	45 Kg	*47.5 Kg*
	55 Kg	*50 Kg*	*52.5 Kg*

Express P as deviation from contemporary group mean
e.g. 57 Kg male twin has a P of 57-55 Kg = 2 Kg

Adjustment for fixed effects

	Single	Twins	
Males	60 Kg	55 Kg	*57.5 Kg*
Females	50 Kg	45 Kg	*47.5 Kg*
	55 Kg	*50 Kg*	*52.5 Kg*

Adjust for effects separately- only applicable in absence of interactions between effects

- 57 Kg male twin is advantaged by 5 Kg for being male and disadvantaged by 2.5 Kg for being a twin
- Adjusted P = 57 - 5 + 2.5 = 54.5 Kg
- P (as deviation from overall mean) = 2 Kg

Accuracy of EBVs

Defined as the correlation (r) between the true breeding value (A) and the estimated breeding value (I) ➔ r_{IA}

Accuracy increases when
- more information is used (relatives, correlated traits)
- heritability is higher

Accuracy of mid-parent EBV depends on accuracy of parent EBVs (and not h^2)

Accuracy of siblings is a maximal of 0.5 for half-sibs and 0.71 for full-sibs.

Progeny tests give the highest accuracies (approaches 1.0)

Accuracies can be calculated from selection index theory

Examples of accuracies

Information	h^2=0.10	h^2=0.30	Comment
Sire EBV (r_{IA}=0.5)	0.25	0.25	Dependant on accuracy of parental EBVs
Sire EBV (r_{IA}=0.5) + Dam EBV (r_{IA}=0.5)	0.35	0.35	
Sire EBV (r_{IA}=0.9) + Dam EBV (r_{IA}=0.5)	0.51	0.51	
Own performance	0.32	0.55	$\sqrt{h^2}$
Own performance + Sire EBV (r_{IA}=0.9) + Dam EBV (r_{IA}=0.5)	0.57	0.66	
Mean of 10 half-sibs	0.23	0.33	
Mean of 1000 half-sibs	0.49	0.50	Max is $\sqrt{0.25}$
Mean of 1000 full-sibs	0.70	0.71	Max is $\sqrt{0.50}$
Mean of 20 progeny	0.58	0.79	
Mean of 1000 progeny	0.98	0.99	

Variance of EBVs

Variance of EBVs = accuracy squared multiplied by the true breeding value

- $V_{EBV}=r_{IA}^2.V_A$

variance of the

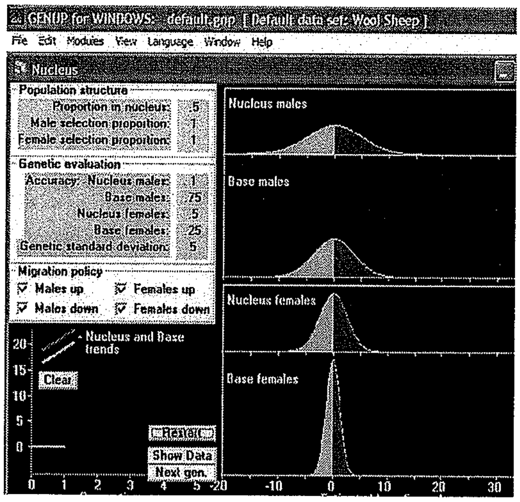
If accuracy = 0, the $V_{EBV}=0$

- All animals have same EBV, no power to discriminate which animals are the best

If accuracy = 1, the $V_{EBV}=V_A$

- Maximal variation in EBVs, good power to discriminate which animals are the best

Variance of EBVs



Accuracy

Message

More information used to calculate EBVs

↓

more accurate EBVs, & greater the EBV variance

↓

more power to discriminate better animals

↓

more response to selection

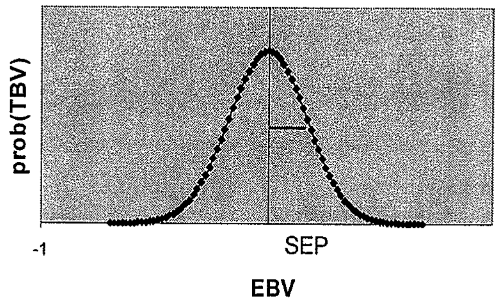
$$R = i\, \sigma_A\, r_{I,A}$$

Properties of BVs

Standard error of prediction

Standard error of prediction relates to the distribution of the TBV around an EBV

Indicates how much an EBV can change with more information



Properties of BVs

$$V_{EBV} = r_{IA}^2 V_A$$

$$PEV = V_{(A-EBV)} = (1 - r_{IA}^2) V_A$$

PEV = Prediction error variance

$$SEP = \sqrt{(1 - r_{IA}^2) V_A}$$

SEP = √PEV

With no information

- accuracy=0, variance of prediction error = V_A

With full information

- accuracy=1, variance of prediction error = 0

$V_A = V_{EBV} + PEV$

Properties of BVs

Standard error of prediction

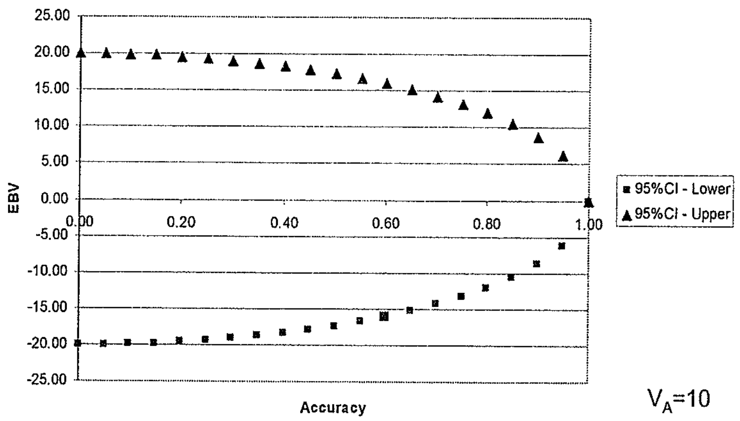
Accuracy	SEP	95%CI	95%CI
0.00	10.00	-20.00	20.00
0.10	9.95	-19.90	19.90
0.20	9.80	-19.60	19.60
0.30	9.54	-19.08	19.08
0.40	9.17	-18.33	18.33
0.50	8.66	-17.32	17.32
0.60	8.00	-16.00	16.00
0.70	7.14	-14.28	14.28
0.80	6.00	-12.00	12.00
0.90	4.36	-8.72	8.72
1.00	0.00	0.00	0.00

V_A=10

EBV=0

Properties of BVs

Standard error of prediction



V_A=10

EBV=0

Final comments

Accuracy and selection

- Should only animals with high accuracy (low SEP) be used as breeders?

- Depends on attitude towards risk
  - Animals with low accuracy may not perform as predicted – chance of obtaining higher merit progeny (but equal chance of obtaining lower merit progeny)
  - Animals with high accuracy perform close to predicted