## Theory on derivation of standardization factors

Daughter yield deviations within country should be standardized by the standard deviation of the true sire effect - std(s). The following approximation of std(s) was considered: Assume, for a moment, that national proofs are obtained by a model similar to the international linear model.

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|---|---|---|
| Let | Y: | daughter yield deviations |
| | s: | true sire effect |
| | b: | various fixed effects |
| | e: | residual |
| | P: | national proof (estimated transmitting ability) |
| | Var(Y): | variance of daughter yield deviations |
| | Var(s): | variance of sire true transmitting ability |
| | Var(P): | variance of sire estimated transmitting ability (proof) |
| | Var(e): | variance of residual |
| | n: | number of daughters |
| | k: | var(e) / Var(s) |
| | R: | accuracy of national proof as if it were by a sire (international) model |

The equivalent model is: $Y = b + s + e$

Then $Var(Y) = Var(s) + Var(e)/n$
$= Var(s) + (k/n)*Var(s)$
$= ((n+k)/n)*Var(s)$
$= Var(s)/R^2$

or $Var(s) = R^2*Var(Y)$, but $R^2$ by an animal model is different that what is inferred here, therefore $R^2$ is expressed as the ratio Var(P)/Var(s) and

$Var(s) = (Var(P)*Var(Y))^{1/2}$ and

$std(s) = (std(P)*std(Y))^{1/2}$

The Y variable vector is then divided by std(s) within country. The same std(s) is later used for back transforming international proofs to any country's unit equivalent.