**Supplemental File 1**

**Case study 1:** The linear mixed model used for analysis of entries across locations, seasons and years:

\[
Y_{ijklm} = M + g_i + l_j + (gl)_{ij} + y_l + (gy)_{il} + (gyl)_{ijl} + (gsy)_{ikl} + (gb)_{im} + \varepsilon_{ijklm},
\]  

\[Y_{ijklm}\] is the value of an attribute measured from entry \(i\) in replicate \(m\) at location \(j\) in season \(k\) of year \(l\), and \(i=1,...,ng, j=1,...,nl, k=1,...,ns, l=1,...,ny, m=1,...,nb;\) where \(g, l, s, y\) and \(b\) are entries, locations, seasons, years and replicates, respectively; \(M\) is the overall mean; \(g_i\) is the random effect of entry \(i\), \(N(0, \sigma^2_g)\); \(l_j\) is the fixed effect of location \(j\); \(y_l\) is the fixed effect of year \(l\); \(bjklm\) is the random effect of replicate \(m\) within location \(j\), within season \(k\), within year \(l\), \(N(0, \sigma^2_b)\); \((gl)_{ij}\) is the effect of the interaction between entry \(i\) and location \(j\), \(N(0, \sigma^2_{gl})\); \((gs)_{ik}\) is the random effect of the interaction between entry \(i\) and season \(k\), \(N(0, \sigma^2_{gs})\); \((gy)_{il}\) is the random effect of the interaction between entry \(i\) and year \(l\), \(N(0, \sigma^2_{gy})\); \((sy)_{kl}\) is the interaction between the fixed effects season \(k\) and year \(l\), \(N(0, \sigma^2_{sy})\); \((gly)_{ijl}\) is the random effect of the interaction between entry \(i\), location \(j\) and year \(l\), \(N(0, \sigma^2_{gly})\); \((gsy)_{ikl}\) is the random effect of the interaction between entry \(i\), season \(k\) and year \(l\), \(N(0, \sigma^2_{gsy})\); \((gb)_{im}\) is the effect of the interaction between entry \(i\) and replicate \(m\), \(N(0, \sigma^2_{gb})\); \(\varepsilon_{ijklm}\) is the residual effect for entry \(i\) in replicate \(m\) in location \(j\) during year \(l\), \(N(0, \sigma^2_{\varepsilon})\).

**Case study 2:** The linear mixed model used for analysis of families across seasons and years:

\[
Y_{ijklmn} = M + f_i + y_j + (fy)_{ij} + s_{jk} + (fs)_{ik} + b_{kl} + r_{jklm} + c_{jkln} + \varepsilon_{ijklmn},
\]  

\[Y_{ijklmn}\] is the value of an attribute measured from HS family \(i\) in row \(m\) and column \(n\) of replicate \(l\) nested in season \(k\) in year \(j\) and \(i=1,...,nf, j=1,...,ny, k=1,...,ns, l=1,...,nb, m=1,...,nr, n=1,...,nc;\) where \(f, y, s, b, r\) and \(c\) are half sib families, years, seasons, replicates, rows and columns, respectively; \(M\) is the overall mean; \(f_i\) is the random effect of HS family \(i\), \(N(0, \sigma^2_f)\); \(y_j\) is the fixed effect of year \(j\); \((fy)_{ij}\) is the random effect of the interaction between HS family \(i\) and year \(j\), \(N(0, \sigma^2_{fy})\); \(s_{jk}\) is the fixed effect of season \(k\) within year \(j\); \((fs)_{ij}\) is the random effect of the interaction between HS family \(i\) and season \(k\), \(N(0, \sigma^2_{fs})\); \(b_{kl}\) is the random effect of replicate \(l\) within season \(k\) in year \(j\), \(N(0, \sigma^2_b)\); \(r_{jklm}\) is the random effect of row \(m\) within replicate \(l\) within season \(k\) in year \(j\), \(N(0, \sigma^2_r)\); \(c_{jkln}\) is the random effect of column \(n\) within replicate \(l\) within season \(k\) in year \(j\), \(N(0, \sigma^2_c)\); \(\varepsilon_{ijklmn}\) is the residual effect of HS family \(i\) in row \(m\) and column \(n\) of replicate \(l\) during season \(k\) in year \(j\), \(N(0, \sigma^2_{\varepsilon})\).
**Case study 3:** The completely random linear model used for analysis of families across locations and years:

\[ Y_{ijklmn} = M + f_i + y_j + (fy)_{ij} + l_{jk} + (fl)_{ik} + b_{jkl} + r_{jklm} + c_{jkln} + \varepsilon_{ijklmn}, \quad (7) \]

\( Y_{ijklmn} \) is the value of an attribute measured from HS family \( i \) in row \( m \) and column \( n \) of replicate \( l \) nested in location \( k \) in year \( j \) and \( i=1,...,n_f \), \( j=1,...,n_y \), \( k=1,...,n_l \), \( l=1,...,n_b \), \( m=1,...,n_r \), \( n=1,...,n_c \), where \( f, y, l, b, r \) and \( c \) are half sib families, years, locations, replicates, rows and columns, respectively; \( M \) is the overall mean; \( f_i \) is the random effect of HS family \( i \), \( N(0,\sigma^2_f) \); \( y_j \) is the fixed effect of year \( j \), \( N(0,\sigma^2_y) \); \( l_{jk} \) is the fixed effect of location \( k \) within year \( j \), \( N(0,\sigma^2_l) \); \( (fy)_{ij} \) is the random effect of the interaction between HS family \( i \) and year \( j \), \( (fy)_{ij} \sim N(0,\sigma^2_{fy}) \); \( (fl)_{ik} \) is the random effect of the interaction between HS family \( i \) and location \( k \), \( (fl)_{ik} \sim N(0,\sigma^2_{fs}) \); \( b_{jkl} \) is the random effect of replicate \( l \) within location \( k \) in year \( j \), \( N(0,\sigma^2_b) \); \( r_{jklm} \) is the random effect of row \( m \) within replicate \( l \) within location \( k \) in year \( j \), \( N(0,\sigma^2_r) \); \( c_{jkln} \) is the random effect of column \( n \) within replicate \( l \) within location \( k \) in year \( j \), \( N(0,\sigma^2_c) \); \( \varepsilon_{ijklmn} \) is the residual effect of HS family \( i \) in row \( m \) and column \( n \) of replicate \( l \) at location \( k \) in year \( j \), \( N(0,\sigma^2_\varepsilon) \).