$$Y_{ijk\ell} = \beta_0 + \beta_j^d + \beta_\ell^v + \left(\beta^d \beta^t\right)_{jk} + \left(\beta^d \beta^v\right)_{j\ell} + \left(\beta^d \beta^t \beta^v\right)_{jk\ell} + \gamma_{0i} + \gamma_{0ij} + \gamma_{0ijk} + \varepsilon_{ijk\ell}$$

$$Y_{ijk\ell} = \beta_0 + D_j + V_\ell + (DT)_{jk} + (DV)_{j\ell} + (DTV)_{jk\ell} + \gamma_{0i} + \gamma_{0ij} + \gamma_{0ijk} + \varepsilon_{ijk\ell}$$

$$\ln\left[\mathbb{E}\left(Y_{ijk\ell}\middle|\text{ density, training, variety}\right)\right] = \beta_0+\beta_j^d+\beta_\ell^v+\left(\beta^d\beta^t\right)_{jk}+\left(\beta^d\beta^v\right)_{j\ell}+\left(\beta^d\beta^t\beta^v\right)_{jk\ell}+\gamma_{0i}+\gamma_{0ij}+\gamma_{0ijk}$$

$$\ln\left[\mathbb{E}\left(Y_{ijk\ell}\right| \text{density, training, variety})\right] = \beta_0 + D_j + V_\ell + (DT)_{jk} + (DV)_{j\ell} + (DTV)_{jk\ell} + \gamma_{0i} + \gamma_{0ij} + \gamma_{0ijk}$$

$$\operatorname{logit}\left(P_{ijk\ell}\right) = \beta_0 + \beta_j^d + \beta_\ell^v + \left(\beta^d\beta^t\right)_{jk} + \left(\beta^d\beta^v\right)_{j\ell} + \left(\beta^d\beta^t\beta^v\right)_{jk\ell} + \gamma_{0i} + \gamma_{0ij} + \gamma_{0ijk}$$

$$\operatorname{logit}\left(P_{ijk\ell}\right) = \beta_0 + D_j + V_\ell + \left(DT\right)_{jk} + \left(DV\right)_{j\ell} + \left(DTV\right)_{jk\ell} + \gamma_{0i} + \gamma_{0ij} + \gamma_{0ijk}$$

$$
\begin{cases}
\text{Bloc (Block) :} & \gamma_{0i} \sim \mathcal{N}\left(0, \sigma_1^2\right) \\
\text{Sous-bloc (Block : density) :} & \gamma_{0ij} \sim \mathcal{N}\left(0, \sigma_2^2\right) \\
\text{Sous-sous-bloc (Block : density : training) :} & \gamma_{0ijk} \sim \mathcal{N}\left(0, \sigma_3^2\right)
\end{cases}
$$

$$
\varepsilon_{ijk\ell} \sim \mathcal{N}\left(0, \sigma_\varepsilon^2\right)
$$

$$
\begin{cases}
\text{Bloc (Block) :} & \gamma_{0i} \sim \mathcal{N}\left(0, \sigma_1^2\right) \\
\text{Sous-bloc (Block}\times\text{density) :} & \gamma_{0ij} \sim \mathcal{N}\left(0, \sigma_2^2\right) \\
\text{Sous-sous-bloc (Block}\times\text{density}\times\text{training) :} & \gamma_{0ijk} \sim \mathcal{N}\left(0, \sigma_3^2\right)
\end{cases}
$$

$$
\begin{aligned}
Y_{ijk\ell} = \beta_0 &+ \beta_1 \text{denstity(medium)} + \beta_2 \text{denstity(high)} + \beta_3 \text{variety(Calypso)} + \beta_4 \text{variety(Keitt)} \\
&+ \beta_5 \text{denstity(medium)} \times \text{training(SL)} + \beta_6 \text{denstity(high)} \times \text{training(SL)} \\
&+ \beta_7 \text{denstity(medium)} \times \text{variety(Calypso)} + \beta_8 \text{denstity(high)} \times \text{variety(Calypso)} \\
&+ \beta_9 \text{denstity(medium)} \times \text{variety(Keitt)} + \beta_{10} \text{denstity(high)} \times \text{variety(Keitt)} \\
&+ \beta_{11} \text{denstity(medium)} \times \text{training(SL)} \times \text{variety(Calypso)} \\
&+ \beta_{12} \text{denstity(high)} \times \text{training(SL)} \times \text{variety(Calypso)} \\
&+ \beta_{13} \text{denstity(medium)} \times \text{training(SL)} \times \text{variety(Keitt)} \\
&+ \beta_{14} \text{denstity(high)} \times \text{training(SL)} \times \text{variety(Keitt)} \\
&+ \gamma_{0i} + \gamma_{0ij} + \gamma_{0ijk} + \varepsilon_{ijk\ell}
\end{aligned}
$$

$$
\begin{aligned}
&\ln\left[\mathbb{E}\left(Y_{ijk\ell}\right| \text{density, training, variety})\right] = \\
&\quad \beta_0 + \beta_1\text{denstity(medium)} + \beta_2\text{denstity(high)} + \beta_3\text{variety(Calypso)} + \beta_4\text{variety(Keitt)} \\
&\quad + \beta_5\text{denstity(medium)} \times \text{training(SL)} + \beta_6\text{denstity(high)} \times \text{training(SL)} \\
&\quad + \beta_7\text{denstity(medium)} \times \text{variety(Calypso)} + \beta_8\text{denstity(high)} \times \text{variety(Calypso)} \\
&\quad + \beta_9\text{denstity(medium)} \times \text{variety(Keitt)} + \beta_{10}\text{denstity(high)} \times \text{variety(Keitt)} \\
&\quad + \beta_{11}\text{denstity(medium)} \times \text{training(SL)} \times \text{variety(Calypso)} \\
&\quad + \beta_{12}\text{denstity(high)} \times \text{training(SL)} \times \text{variety(Calypso)} \\
&\quad + \beta_{13}\text{denstity(medium)} \times \text{training(SL)} \times \text{variety(Keitt)} \\
&\quad + \beta_{14}\text{denstity(high)} \times \text{training(SL)} \times \text{variety(Keitt)} \\
&\quad + \gamma_{0i} + \gamma_{0ij} + \gamma_{0ijk}
\end{aligned}
$$

$$
\begin{aligned}
&\text{logit}\left(P_{ijk\ell}\right) = \\
&\quad \beta_0 + \beta_1\text{denstity(medium)} + \beta_2\text{denstity(high)} + \beta_3\text{variety(Calypso)} + \beta_4\text{variety(Keitt)} \\
&\quad + \beta_5\text{denstity(medium)} \times \text{training(SL)} + \beta_6\text{denstity(high)} \times \text{training(SL)} \\
&\quad + \beta_7\text{denstity(medium)} \times \text{variety(Calypso)} + \beta_8\text{denstity(high)} \times \text{variety(Calypso)} \\
&\quad + \beta_9\text{denstity(medium)} \times \text{variety(Keitt)} + \beta_{10}\text{denstity(high)} \times \text{variety(Keitt)} \\
&\quad + \beta_{11}\text{denstity(medium)} \times \text{training(SL)} \times \text{variety(Calypso)} \\
&\quad + \beta_{12}\text{denstity(high)} \times \text{training(SL)} \times \text{variety(Calypso)} \\
&\quad + \beta_{13}\text{denstity(medium)} \times \text{training(SL)} \times \text{variety(Keitt)} \\
&\quad + \beta_{14}\text{denstity(high)} \times \text{training(SL)} \times \text{variety(Keitt)} \\
&\quad + \gamma_{0i} + \gamma_{0ij} + \gamma_{0ijk}
\end{aligned}
$$

$$
\begin{cases}
i = 1, 2, 3 \\
j = 1 \text{ (Low)},\ 2 \text{ (Medium)},\ 3 \text{ (High)} \\
k = 1 \text{ (Conv)},\ 2 \text{ (SL)} \\
\ell = 1 \text{ (1243)},\ 2 \text{ (Calypso)},\ 3 \text{ (Keitt)}
\end{cases}
$$

$$Y_{ijk\ell} = \beta_0 + \beta_j^{\mathrm{GC}} + \beta_k^{\mathrm{trt}} + \beta_\ell^{\mathrm{var}} + \left(\beta^{\mathrm{GC}}\beta^{\mathrm{trt}}\right)_{jk} + \left(\beta^{\mathrm{GC}}\beta^{\mathrm{var}}\right)_{j\ell} + \left(\beta^{\mathrm{trt}}\beta^{\mathrm{var}}\right)_{k\ell} + \left(\beta^{\mathrm{GC}}\beta^{\mathrm{trt}}\beta^{\mathrm{var}}\right)_{jk\ell} + \varepsilon_{ijk\ell}$$

$$\varepsilon_{ijk\ell} \sim \mathcal{N}\left(0, \sigma^2\Lambda_i\right)$$

$$
\begin{aligned}
Y_{ijk\ell} = \beta_0 &+ \beta_1 \,\text{variety(Calypso)} + \beta_2 \,\text{variety(Keitt)} + \beta_3 \,\text{treatment}(3) + \beta_4 \,\text{treatment}(5) \\
&+ \beta_5 \,\text{variety(Calypso)} \times \text{treatment}(3) + \beta_6 \,\text{variety(Keitt)} \times \text{treatment}(3) \\
&+ \beta_7 \,\text{variety(Calypso)} \times \text{treatment}(5) + \beta_8 \,\text{variety(Keitt)} \times \text{treatment}(5) \\
&+ \gamma_{0i} + \gamma_{0ij} + \gamma_{0ijk} + \varepsilon_{ijk\ell}
\end{aligned}
$$

Est-ce que ce ne serait pas mieux de mettre : au lieu de $\times$ pour les intéractions ?

$$
\begin{aligned}
Y_{ijk\ell} = \beta_0 &+ \beta_1 \text{variety(Calypso)} + \beta_2 \,\text{variety(Keitt)} + \beta_3 \,\text{treatment}(3) + \beta_4 \,\text{treatment}(5) \\
&+ \beta_5 \,\text{variety(Calypso)} : \text{treatment}(3) + \beta_6 \,\text{variety(Keitt)} : \text{treatment}(3) \\
&+ \beta_7 \,\text{variety(Calypso)} : \text{treatment}(5) + \beta_8 \,\text{variety(Keitt)} : \text{treatment}(5) \\
&+ \gamma_{0i} + \gamma_{0ij} + \gamma_{0ijk} + \varepsilon_{ijk\ell}
\end{aligned}
$$

$$
\begin{cases}
\beta^d_j & \text{estimation de la densité } j, \\
\beta^v_\ell & \text{estimation de la variété } \ell, \\
\left(\beta^d\beta^t\right)_{jk} & \text{estimation de l'interaction entre la densité } j \text{ et le mode de conduite } k, \\
\left(\beta^d\beta^v\right)_{j\ell} & \text{estimation de l'interaction entre la densité } j \text{ et la variété } \ell, \\
\left(\beta^d\beta^t\beta^v\right)_{jk\ell} & \text{estimation de la triple interaction entre la densité } j\text{, le mode de conduite } k \text{ et la variété } \ell.
\end{cases}
$$

$$
\begin{cases}
\beta^d_j & \text{estimation de la densité } j, \\
\beta^v_\ell & \text{estimation de la variété } \ell, \\
\left(\beta^d\beta^t\right)_{jk} & \text{estimation de l'interaction entre la densité } j \text{ et le mode de conduite } k, \\
\left(\beta^d\beta^v\right)_{j\ell} & \text{estimation de l'interaction entre la densité } j \text{ et la variété } \ell, \\
\left(\beta^d\beta^t\beta^v\right)_{jk\ell} & \text{estimation de la triple interaction entre la densité } j\text{, le mode} \\
 & \text{de conduite } k \text{ et la variété } \ell.
\end{cases}
$$

Faudrait-pas des $\hat{\beta}$ si c'est des estimations ?