Stability assessment

1. Incorporating regression terms in basic MET mixed model

Basic model in lme4

Genetic trend: βr_i
Agronomic trend: γt_k

```
lmer(formula = G.ari.mean ~ r.i + t.k +
       (1|G) + (1|L) + (1|Y) + (1|Y:L) + (1|L:G) + (1|Y:G),
     data    = dat)
```

Basic model for long-term MET data

$$y_{ijk} = \mu + G_i + L_j + Y_k + (LY)_{jk} + (GL)_{ij} + (GY)_{ik} + (GLY)_{ijk} \quad (1)$$

y_{ijk} = mean yield of the *i*-th genotype in the *j*-th location and *k*-th year
μ = overall mean
G_i = main effect of the *i*-th genotype
L_j = main effect of the *j*-th location
Y_k = main effect of the *k*-th year
$(LY)_{jk}$ = *jk*-th location × year interaction
$(GL)_{ij}$ = *ij*-th genotype × location interaction
$(GY)_{ik}$ = *ik*-th genotype × year interaction
$(GLY)_{ijk}$ = residual comprising both genotype × location × year interaction as well as the error of a mean

2. Incorporating regression terms

Genetic trend

$$G_i = \beta r_i + H_i \quad (2)$$

β = fixed regression coefficient for genetic trend
r_i = year of first trial for *i*-th variety
$H_i \sim N(0, \sigma_H^2)$

Non-genetic trend

$$Y_k = \gamma t_k + Z_k \quad (3)$$

γ = fixed regression coefficient for agronomic trend
t_k = calendar year
$Z_k \sim N(0, \sigma_Z^2)$

Basic model in ASReml-R

Genetic trend: βr_i
Agronomic trend: γt_k

```
Basic <- asreml(fixed   = adj.mean ~ r.i + t.k,
                random  = ~ GG + L + Y + Y:L + L:GG + Y:GG +
                  GG:Y:L,
                weights = w,
                family  = asreml.gaussian(dispersion=1.0),
                data    = dat)
```

Basic model for long-term MET data

$$y_{ijk} = \mu + G_i + L_j + Y_k + (LY)_{jk} + (GL)_{ij} + (GY)_{ik} + (GLY)_{ijk} \quad (1)$$

y_{ijk} = mean yield of the *i*-th genotype in the *j*-th location and *k*-th year
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$(LY)_{jk}$ = *jk*-th location × year interaction
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Stability assessment

1. Incorporating regression terms in basic MET mixed model
2. Stability variances
   - Shukla's stability variance (Heterogeneous variances)

Shukla‘s stability variance

Genetic trend: βr_i
Agronomic trend: γt_k

```
shukla <- asreml(fixed    = adj.mean ~ r.i + t.k,
                 random   = ~ GG + L + Y + Y:L + L:GG + Y:GG +
                              at(GG):Y:L,
                 weights = w,
                 family  = asreml.gaussian(dispersion=1.0),
                 data     = dat)
```

Stability assessment

1. Incorporating regression terms in basic MET mixed model
2. Stability variances
   - Shukla's stability variance (Heterogeneous variances)
   - Finlay-Wilkinson mixed model extension (FA var. Structure)

Factor-analytic model

Genetic trend: βr_i
Agronomic trend: γt_k

```
FA <- asreml(fixed   = adj.mean ~ r.i + t.k,
             random  = ~ GG + L + Y + L:GG + Y:GG +
                         fa(GG):Y:L,
             weights = w,
             family  = asreml.gaussian(dispersion=1.0),
             data    = dat)
```

Stability assessment

Basic

GG:Y:L

	CovParm	estimate
1:	L	0.2170
2:	Y	0.0382
3:	GG	0.2858
4:	Y:L	0.5071
5:	L:GG	0.0544
6:	Y:GG	0.0226
7:	GG:Y:L	0.2739
8:	R	1.0000

Shukla

at(GG):Y:L

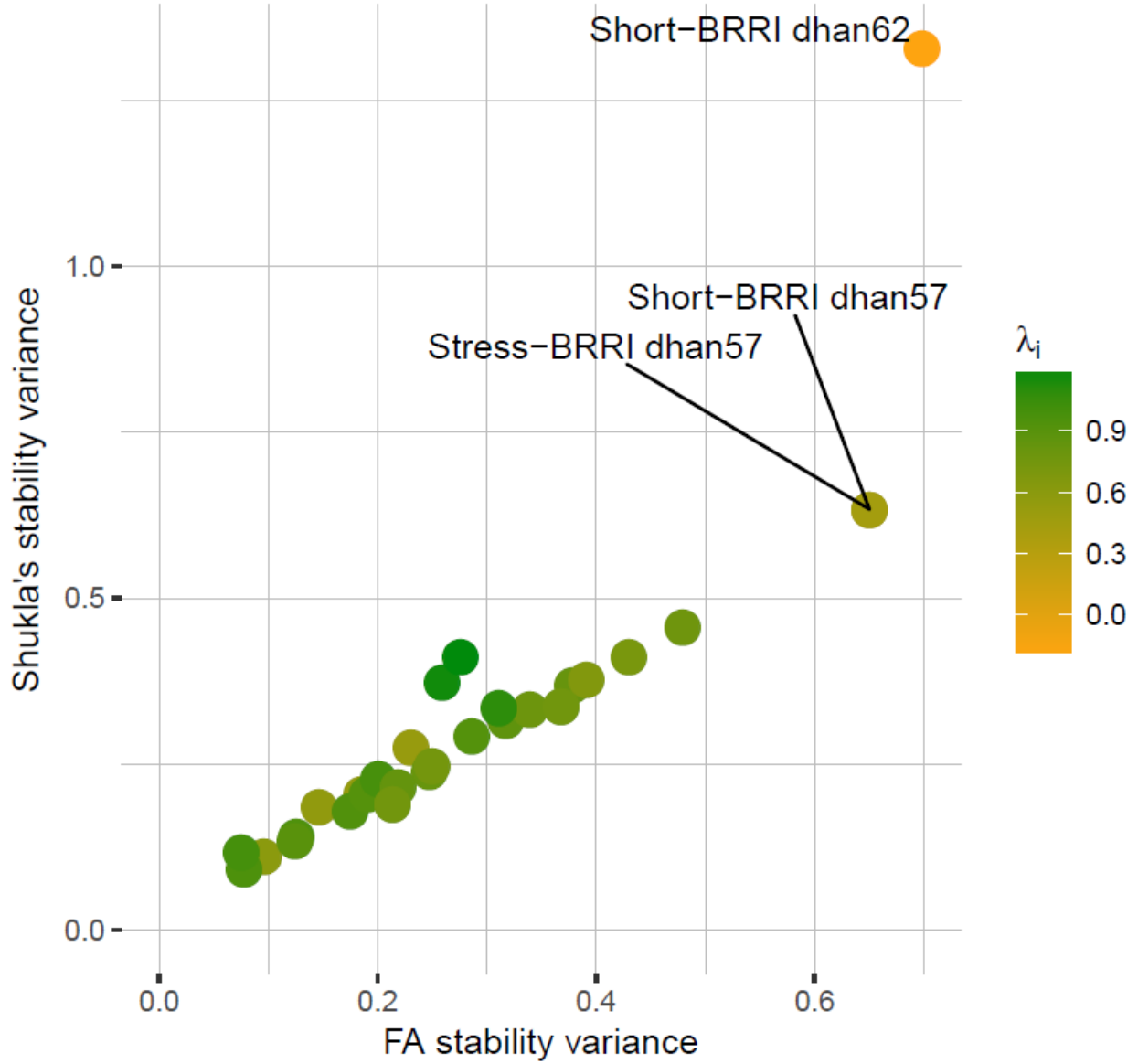
	CovParm	estimate
1:	GG	0.2843
2:	L	0.2179
3:	Y	0.0377
4:	Y:L	0.4971
5:	L:GG	0.0494
6:	Y:GG	0.0245
7:	Aromatic-BR5	0.2740
8:	Aromatic-BRRI dhan34	0.2037
9:	Aromatic-BRRI dhan37	0.1853
	• • •	
36:	Stress-BRRI dhan56	0.3777
37:	Stress-BRRI dhan57	0.6340
38:	Stress-BRRI dhan66	0.3372
39:	R	1.0000

FA

fa(GG):Y:L

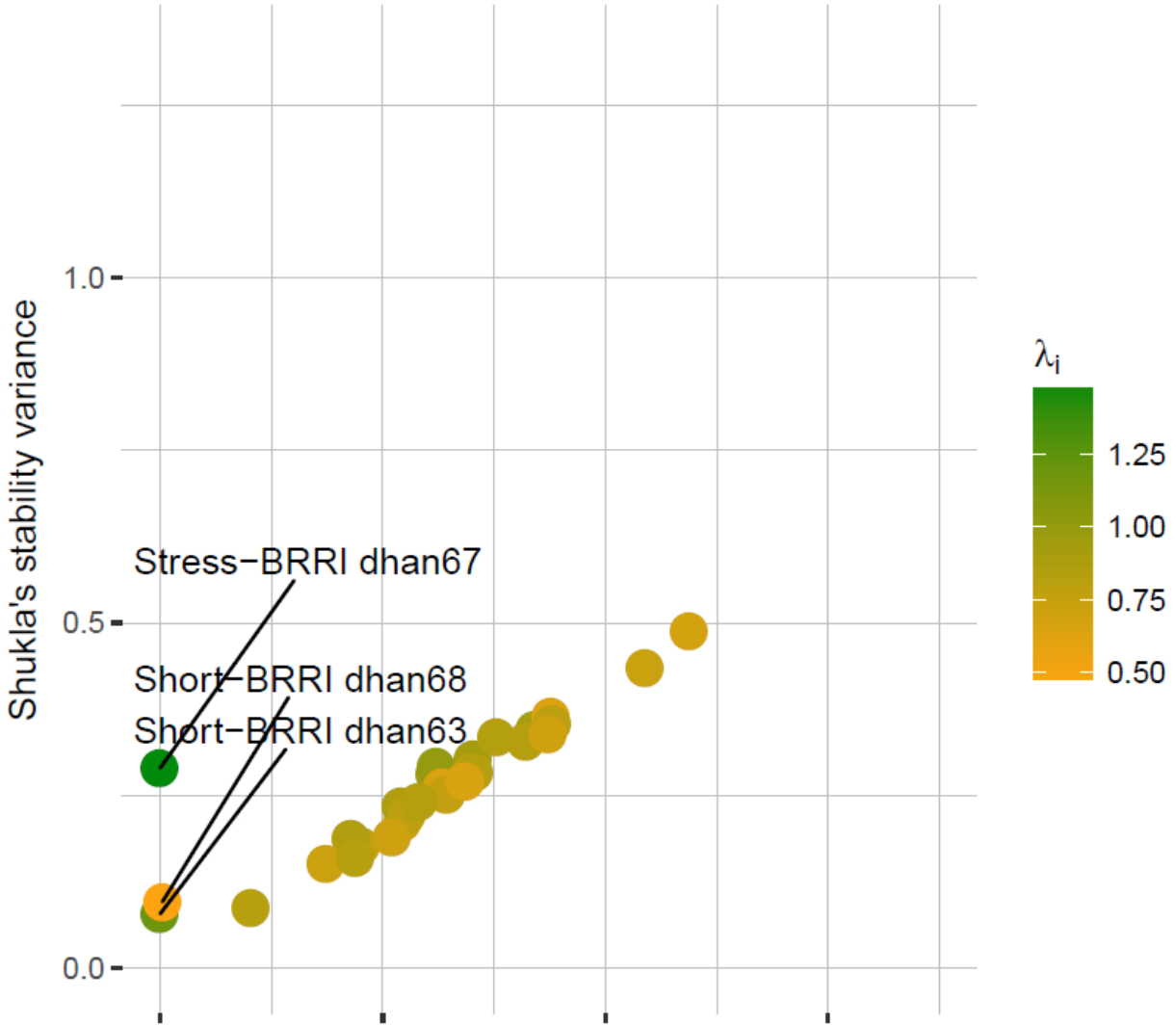
	CovParm	lambda	sigma
1:	GG	NA	0.2377
2:	L	NA	0.2709
3:	Y	NA	0.0626
4:	L:GG	NA	0.0375
5:	Y:GG	NA	0.0141
6:	R	NA	1.0000
7:	Aromatic-BR5	0.5193	0.2309
8:	Aromatic-BRRI dhan34	0.5409	0.1847
9:	Aromatic-BRRI dhan37	0.5576	0.1470
	• • •		
36:	Stress-BRRI dhan56	0.6515	0.3916
37:	Stress-BRRI dhan57	0.4341	0.6502
38:	Stress-BRRI dhan66	0.7568	0.3685

Stability assessment



Stability variances for aman dataset.

Stability assessment



Stability variances for boro dataset.