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Integrating mixed-effect models into an architectural plant model to simulate inter- and intra-progeny variability: a case study on oil palm

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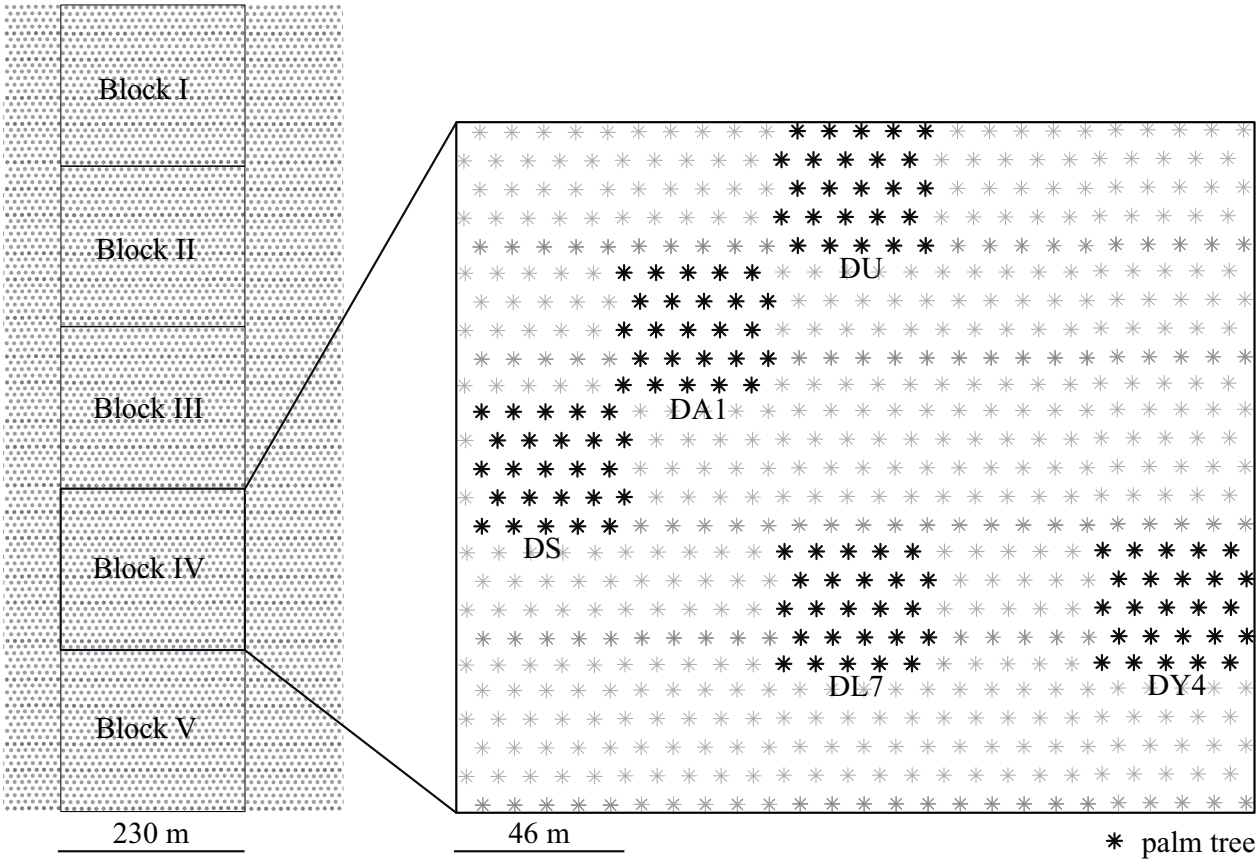

Fig. S1 Experimental design with the location of the 5 elementary parcels of the studied progenies (in black). Measurements were done on a single block to limit environmental variations.

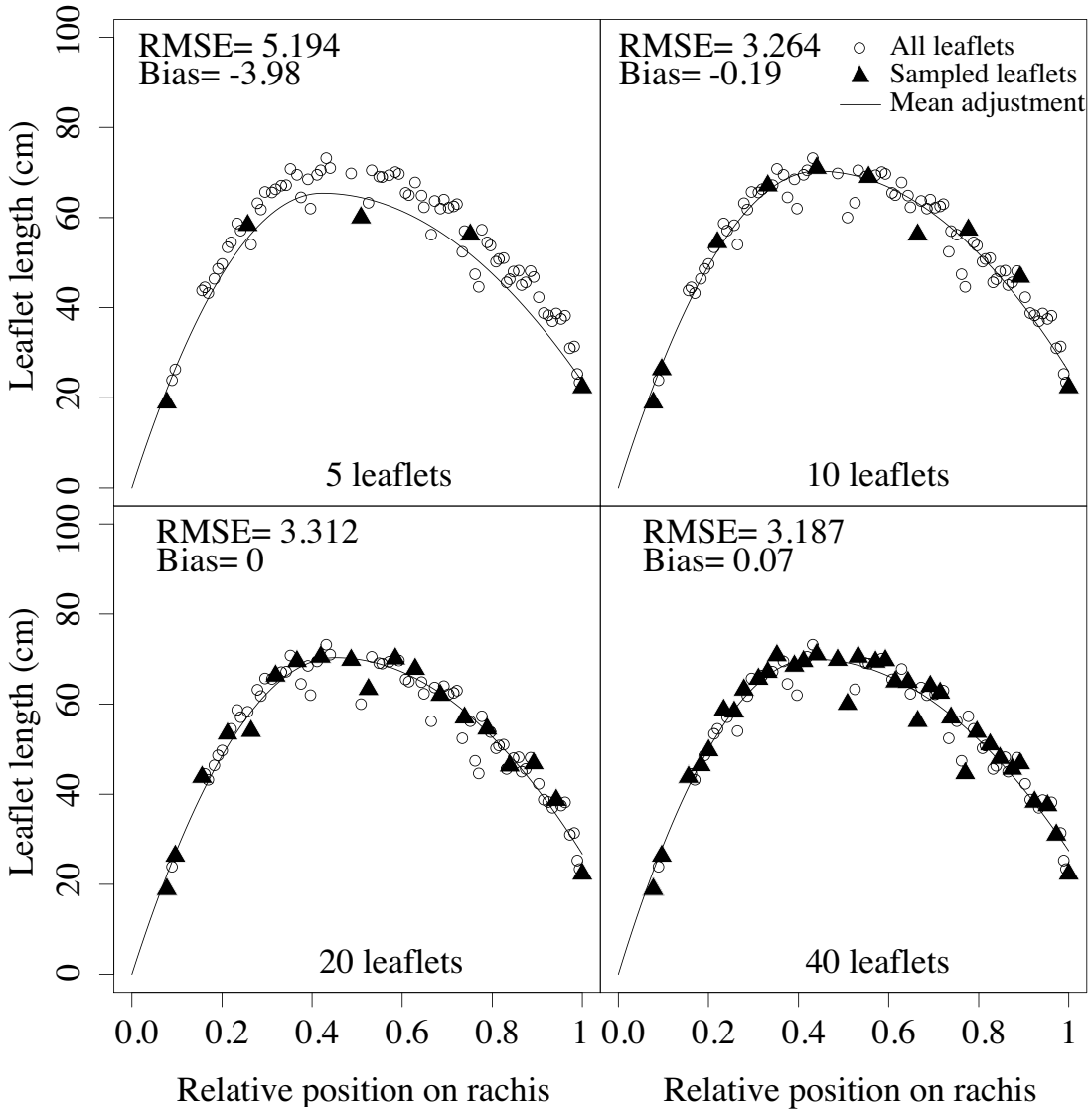

Fig. S2 Leaflet length adjustment (lines) with different sample size from observed data (circles). For each subsample (black triangles), leaflets were selected at constant intervals along the rachis. (RMSE: root mean square error).

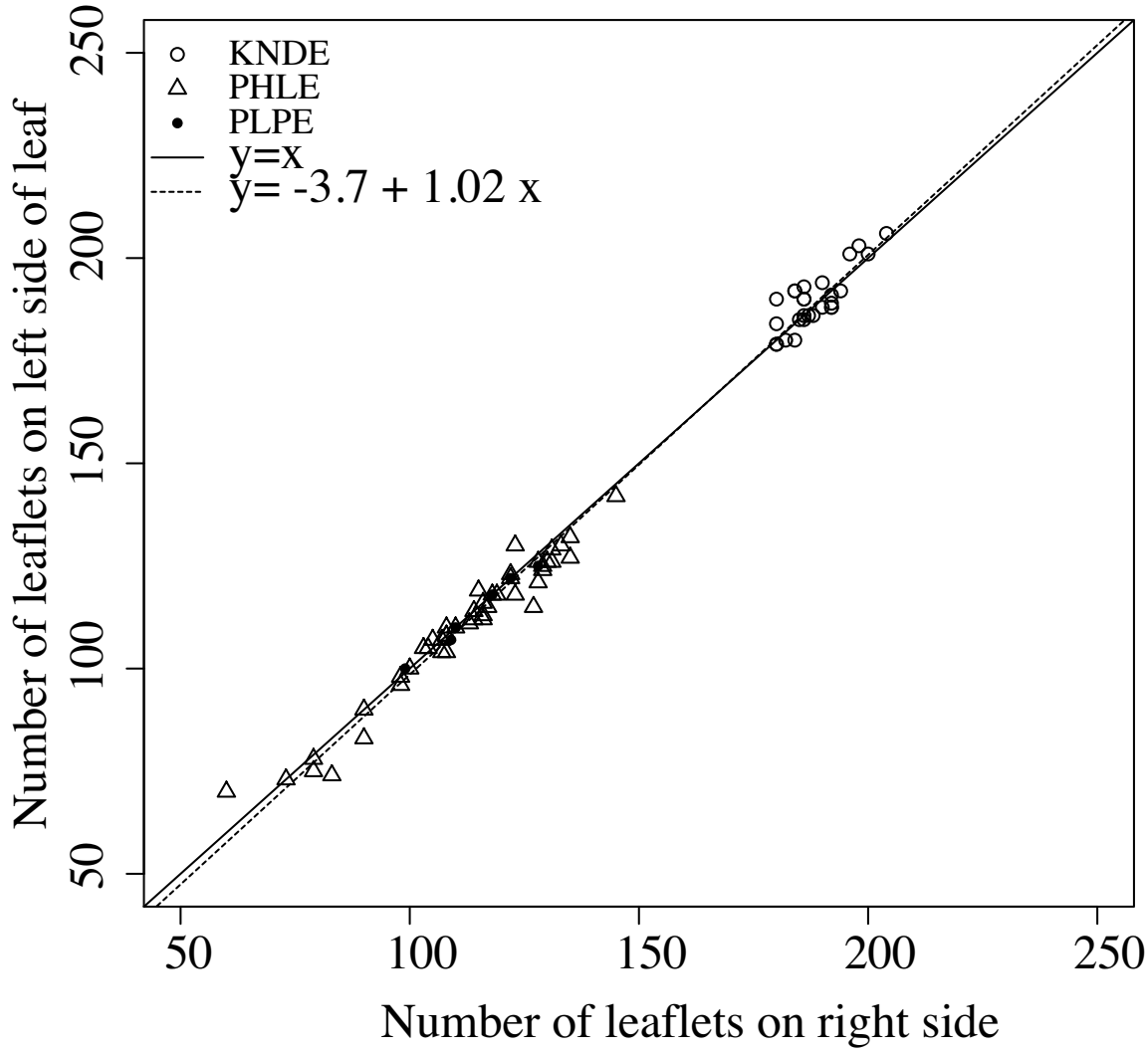

Fig. S3 Comparison of the number of leaflets on each side of rachis. Data were collected in 93 leaves in three different trials (KNDE: Deli x Avros, adult plants; PHLE: Deli x Avros, young plants; PLPE: Deli x Lamé, young plants).

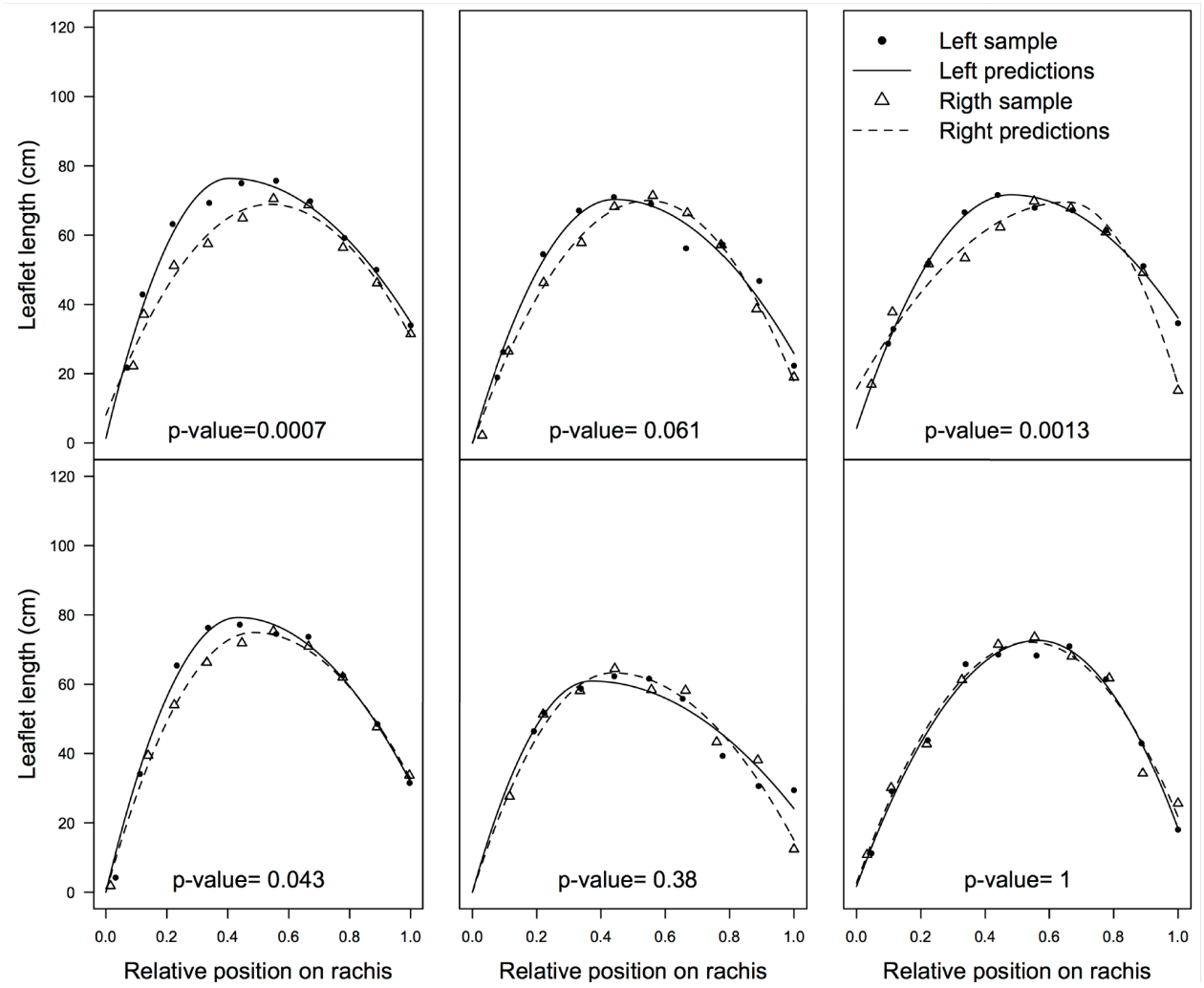

Fig. S4 Length of leaflets along the rachis measured on each side of leaf. P-value corresponds to the likelihood ratio test performed on fitted parameters for the right and left sides of the leaf (leaf is considered symmetric when p-value > 0.05).

Table S1: Progenies description.

Reference	Progeny	Origin	Characteristics
DA1	Deli x Avros	South East Asia	Large vegetative apparatus
DL7	Deli x La Mé	Africa	Low vegetative apparatus High yield
DS	Deli x (La Mé x Sibiti)	Africa	Medium vegetative apparatus Medium yield
DU	Deli x Unknown	Africa	Medium vegetative apparatus Drought tolerance
DY4	Deli x Yangambi	Africa	Medium vegetative apparatus Medium yield

Table S2 : Monitoring of data collection

Variables	Number of observations per progeny		
	Every 6 months from planting	30 months after planting	47 months after planting
Leaf number ($\sum leaves$)	25 plants		
Stem height (H)		9 plants	12 plants
Stem basal diameter (D)	25 plants	9 plants	12 plants
Declination at C point (δ_C)		5 leaves x 4 plants	10 leaves x 9 plants
Rachis angles (δ, Δ, θ)		5 leaves x 4 plants	3 leaves x 4 plants
Leaf length (L_{rac}):			
-Rank17	25 plants	6 plants	
-Others ranks		6 leaves x 4 plants	4 leaves x 12 plants
Number of leaflets ($NbLft$)	25 plants	6 plants	12 plants
Leaf area ($Area$)		1 leaf x 4 plants	1 leaf x 6 plants
Leaflet length (L)	4 leaflets x 1 leaf x 25 plants	10 leaflets x 1 leaf x 4 plants	10 leaflets x 1 leaf x 6 plants
Leaflet width (W)		10 leaflets x 1 leaf x 4 plants	10 leaflets x 1 leaf x 6 plants
Leaflet angles (α, ρ)		10 leaflets x 1 leaf x 4 plants	

Table S3 Mean and standard deviation (in parentheses) of parameters used in allometric relationships for the five studied progenies (covariance between parameters are not presented).

		Progeny				
Variables	Parameters	DA1	DL7	DS	DU	DY4
H	h_0	5	5	5	5	5
	h_g	0.021	0.025	0.025	0.025	0.026
D	D_{max}	77.5	76.0	76.9	70.5	81.7
	D_{slp}	0.007	0.005	0.007	0.007	0.005
	$L_{D\ infl}$	168.8	153.1	165.1	160.8	175.4
φ	φ	136.9(0.73)	136.9(0.73)	136.9(0.73)	136.9(0.73)	136.9(0.73)
L_{rac}	L_{racint}	65.5 (20.2)	77.2 (33.0)	98.0 (18.61)	84.1 (12.872)	91.8 (21.113)
	L_{racslp}	3.39 (0.31)	3.16 (0.60)	2.91 (0.25)	3.33 (0.32)	3.32 (0.47)
L_p	$ratio_L$	0.32 (0.03)	0.26 (0.02)	0.23 (0.02)	0.27 (0.02)	0.26 (0.03)
$N\,bLf\,t$	Nb_{max}	134	124	138	132	130
	Nb_{slp}	0.003	0.005	0.004	0.004	0.005
	L_{Nbinfl}	151.3	153.1	152.0	153.0	155.0
δC	δ_{Cint}	9.1 (2.0)	12.3 (3.0)	12.5 (3.4)	10.8 (3.4)	9.7 (0.8)
	δ_{Cslp}	1.49 (0.07)	1.45 (0.09)	1.33 (0.13)	1.67 (0.05)	1.54 (0.13)
δA	δ_{Amax}	180	143	146	134	141
	δ_{Aslp}	0.007	0.018	0.017	0.012	0.016
	δ_{Ainfl}	40.2	24.6	19.7	12.3	15.1
δ	δ_{sf}	1.739 (1.61)	1.343 (0.571)	3.855 (2.856)	2.566 (2.626)	2.012 (0.634)
Δ	Δ_a	8.4 (9.3)	5.0 (4.8)	4.8 (6.2)	3.4 (2.8)	5.5 (6.8)
	Δ_{sf}	2	2	2	2	2
θ	θ_a	19.6(10.8)	15.5 (12.8)	16.9 (12.2)	15.6 (12.1)	18.8 (10.4)
	θ_s	3	3	3	3	3
$PosLft_{rel}$	d_{Lft}	2.21	2.32	2.31	2.36	2.41
L_B	L_{Bint}	17.75 (3.2)	25.45 (3.15)	28.84 (4.61)	23.49 (3.60)	28.78 (0.72)
	L_{Bslp}	0.18 (0.02)	0.13 (0.01)	0.14 (0.01)	0.15 (0.01)	0.13 (0.01)
	$PosB_{rel}$	0.63	0.60	0.608	0.624	0.62
W_B	W_{Bint}	2.6 (0.1)	2.2 (0.1)	2.9 (0.1)	2.2 (0.2)	3.1 (0.0)
	W_{Bslp}	0.005 (0.000)	0.006 (0.001)	0.005 (0.000)	0.008 (0.001)	0.004 (0.000)
L_{rel}	l_c	0.18 (0.02)	0.04 (0.01)	0.04 (0.04)	0.04 (0.05)	0.23 (0.09)
	p_L	0.47 (0.06)	0.43 (0.03)	0.49 (0.02)	0.46 (0.02)	0.49 (0.06)
	l_a	0.57 (0.08)	0.62 (0.05)	0.48 (0.04)	0.61 (0.06)	0.47 (0.07)
W_{rel}	w_c	0.27 (0.02)	0.22 (0.00)	0.20 (0.02)	0.20 (0.02)	0.25 (0.03)
	p_W	0.63 (0.01)	0.62 (0.02)	0.61 (0.02)	0.61 (0.01)	0.57 (0.03)
	w_a	0.50 (0.04)	0.44 (0.03)	0.43 (0.03)	0.52 (0.05)	0.44 (0.06)
α	α_c	78.2 (0.1)	90.0 (2.8)	86.8 (3.4)	96.9 (2.8)	82.2 (1.7)
	α_a	10.4 (4.8)	25.9 (0.0)	23.6 (11.7)	21.9 (1.5)	15.9 (6.3)
	α_s	-4.69 (0.85)	-29.15 (2.43)	-12.77 (0.89)	-24.90 (4.18)	-21.04 (2.77)
ρ_{Up}	ρ_{CUp}	26.3	41.9	26.4	27.5	20.2
	$\rho_{0.5Up}$	60.5	51.3	52.5	61.5	46.3
ρ_{MedUp}	ρ_{CMedUp}	16.7	10.5	42.9	-2.9	17.3
	$\rho_{0.5MedUp}$	9.1	15.2	16.0	32.5	15.5
ρ_{MedDwn}	$\rho_{CMedDwn}$	-7.9	-2.0	-14.0	2.2	-10.6
	$\rho_{0.5MedDwn}$	-4.8	-3.7	-5.5	-11.8	-8.1
ρ_{Dwn}	ρ_{CDwn}	-12.3	-25.5	-2.3	-28.6	-24.0
	$\rho_{0.5Dwn}$	-34.3	-16.7	-22.9	-19.7	-15.7