**Figure S1.** Relationship between APSIM-simulated values and emulator-predicted values of biomass and CDW in experiment A at each reporting frequency at days after planting (DAP): 96, 117, 147, 173, 244, 293 and 388. Solid lines indicate linear fit to the APSIM-simulated values and emulator-predicted values of biomass and CDW. ▬: Biomass and ▬: CDW. $R^2_{emu}$_Biomass and $R^2_{emu}$ _CDW were calculated by using 200 data points.
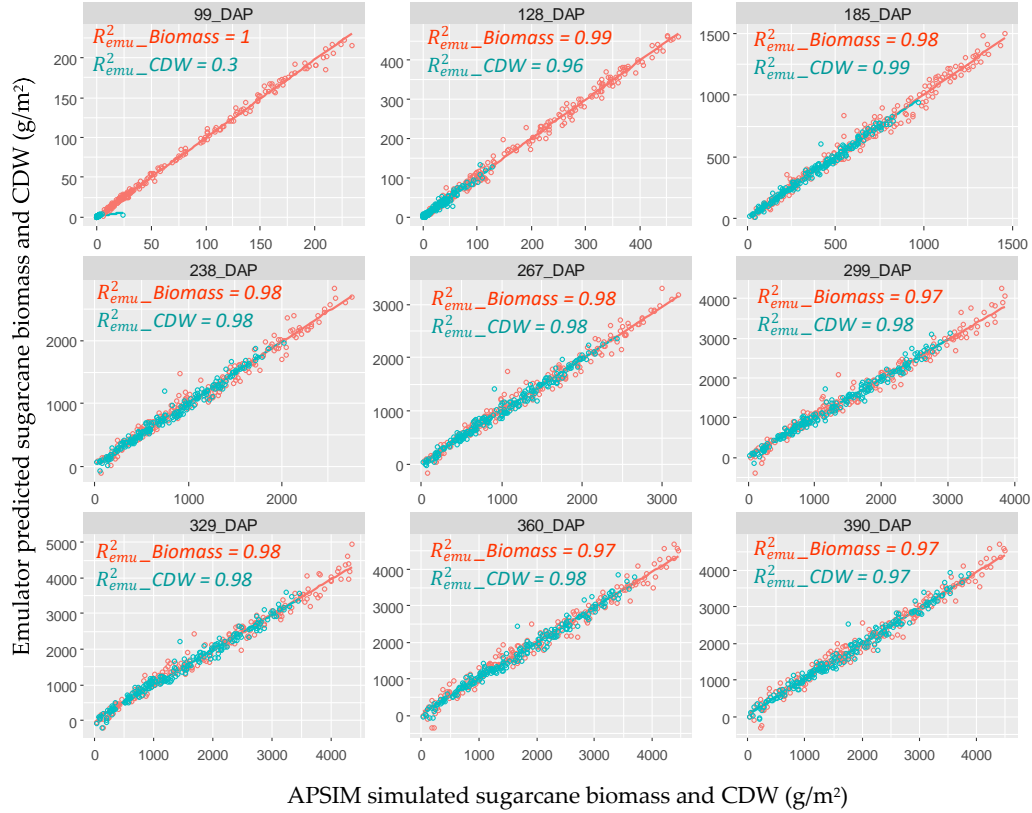


**Figure S2.** Relationship between APSIM-simulated values and emulator-predicted values of biomass and CDW in experiment B2 at each reporting frequency at days after planting (DAP): 99, 128, 185, 238, 267, 299, 329, 360 and 390. Solid lines indicate linear fit to the APSIM-simulated values and emulator-predicted values of biomass and CDW. ▬: Biomass and ▬: CDW. $R^2_{emu}$_Biomass and $R^2_{emu}$_CDW were calculated by using 200 data points.

**Table S1.** Summary of the data collected during field experiments.

| Experiment | Reporting Frequency as DAP | Biomass (gm⁻²) of Each Cultivar | | | CDW (gm⁻²) of Each Cultivar | | |
|---|---|---|---|---|---|---|---|
| | | KK3 | LK92-11 | 02-2-058 | KK3 | LK92-11 | 02-2-058 |
| | 96 | 34 | 37 | 38 | 22 | 23 | 26 |
| | 117 | 49 | 74 | 51 | 39 | 56 | 39 |
| | 147 | 255 | 372 | 271 | 188 | 251 | 195 |
| A | 173 | 700 | 960 | 824 | 451 | 601 | 568 |
| | 244 | 2362 | 2580 | 1978 | 1676 | 1904 | 1340 |
| | 298 | 2902 | 2802 | 2228 | 2386 | 2410 | 1844 |
| | 388 | 3425 | 4705 | 3359 | 2623 | 4029 | 2527 |
| | 99 | 1000 | 160 | 540 | 260 | 83 | 90 |
| | 128 | 1370 | 1846 | 1140 | 529 | 573 | 480 |
| | 185 | 3820 | 2700 | 3210 | 2222 | 1300 | 1720 |
| | 238 | 4420 | 3890 | 3890 | 3030 | 2404 | 2460 |
| B1 | 267 | 5120 | 4280 | 5180 | 3470 | 2730 | 3430 |
| | 299 | 5650 | 4510 | 4700 | 4545 | 3150 | 3500 |
| | 329 | 5390 | 4890 | 5550 | 4200 | 3920 | 4060 |
| | 360 | 6220 | 5070 | 6000 | 5010 | 3890 | 4400 |
| | 390 | 5850 | 4870 | 6470 | 4760 | 3610 | 4390 |
| | 99 | 170 | 220 | 220 | 30 | 30 | 40 |
| | 128 | 740 | 650 | 490 | 130 | 100 | 80 |
| | 185 | 1260 | 1130 | 1470 | 420 | 430 | 570 |
| | 238 | 2490 | 2780 | 2620 | 1550 | 1630 | 1440 |
| B2 | 267 | 2810 | 2560 | 2700 | 1690 | 1540 | 1580 |
| | 299 | 3640 | 3410 | 3510 | 2460 | 2100 | 2380 |
| | 329 | 3860 | 3560 | 4790 | 2830 | 2380 | 3270 |
| | 360 | 4050 | 3790 | 4090 | 3110 | 2540 | 2890 |
| | 390 | 4830 | 3950 | 4180 | 3730 | 2760 | 2990 |

**Table S2.** Best estimated parameter ensembles obtained for biomass and CDW of cultivar KK3 based on the emulators of experiments A, B1 and B2.

| Parameter Name | Code | LK92-11 | | | | | |
|---|---|---|---|---|---|---|---|
| | | A | | B1 | | B2 | |
| | | Biomass | CDW | Biomass | CDW | Biomass | CDW |
| | LS1 | 1723 | 1956 | 674 | 715 | 1792 | 1918 |
| *leaf_size* | LS2 | 68,040 | 68,539 | 26,182 | 44,747 | 56,809 | 41,153 |
| | LS3 | 39,680 | 22,241 | 39,535 | 44,618 | 68,364 | 57,330 |
| *cane_fraction* | CF | 0.65 | 0.65 | 0.65 | 0.67 | 0.66 | 0.70 |
| *sucrose_fraction_stalk* | SFS | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 |
| *stress_factor_stalk* | SF | 0.9 | 1.0 | 0.6 | 0.4 | 0.9 | 0.2 |
| *sucrose_delay* | SD | 591 | 557 | 583 | 29 | 563 | 531 |
| *min_sstem_sucrose* | MSS | 597 | 1358 | 1340 | 1310 | 1097 | 1317 |
| *min_sstem_sucrose_redn* | MSSR | 1 | 0.03 | 2 | 19 | 0.26 | 6 |
| *tt_emerg_to_begcane* | EB | 1894 | 1883 | 1730 | 1264 | 1874 | 1889 |
| *tt_begcane_to_flowering* | BF | 6594 | 6576 | 5467 | 5851 | 5748 | 6569 |
| *tt_flowering_to_crop_end* | FC | 1777 | 2220 | 1958 | 2105 | 2153 | 1776 |
| *green_leaf_no* | GLN | 15 | 15 | 10 | 12 | 15 | 15 |
| | TLS1 | 5 | 6 | 5 | 4 | 4 | 5 |
| | TLS2 | 6 | 6 | 6 | 3 | 4 | 5 |
| *tillerf_leaf_size* | TLS3 | 6 | 2 | 1 | 3 | 1 | 2 |
| | TLS4 | 6 | 6 | 5 | 1 | 5 | 5 |
| | TLS5 | 3 | 4 | 3 | 5 | 3 | 1 |
| | TEC1 | 0.006 | 0.007 | 0.008 | 0.012 | 0.014 | 0.013 |
| *transp_eff_cf* | TEC2 | 0.012 | 0.009 | 0.010 | 0.007 | 0.014 | 0.011 |
| | TEC3 | 0.014 | 0.013 | 0.014 | 0.012 | 0.013 | 0.014 |
| | TEC4 | 0.014 | 0.014 | 0.013 | 0.014 | 0.009 | 0.008 |

| Parameter Name | Code | A | | B1 | | B2 | |
|---|---|---|---|---|---|---|---|
| | | Biomass | CDW | Biomass | CDW | Biomass | CDW |
| | TEC5 | 0.013 | 0.013 | 0.014 | 0.011 | 0.013 | 0.011 |
| | TEC6 | 0.008 | 0.007 | 0.010 | 0.007 | 0.014 | 0.007 |
| | RUE3 | 1.42 | 1.32 | 2.49 | 2.13 | 2.24 | 2.04 |
| *rue* | RUE4 | 2.49 | 2.50 | 2.28 | 2.19 | 2.34 | 2.29 |
| | RUE5 | 2.50 | 2.42 | 2.40 | 0.81 | 2.40 | 1.31 |

**Table S3.** Best estimated parameter ensembles obtained for the biomass and CDW of cultivar LK92-11 from the emulators of experiments A, B1 and B2.

| Parameter Name | Code | 02-2-058 | | | | | |
|---|---|---|---|---|---|---|---|
| | | A | | B1 | | B2 | |
| | | Biomass | CDW | Biomass | CDW | Biomass | CDW |
| | LS1 | 1162 | 1527 | 1790 | 1524 | 1157 | 1300 |
| *leaf_size* | LS2 | 69,773 | 64,427 | 20,252 | 30,364 | 36,698 | 50,009 |
| | LS3 | 32,932 | 43,031 | 61,664 | 20,906 | 25,688 | 52,774 |
| *cane_fraction* | CF | 0.72 | 0.77 | 0.68 | 0.74 | 0.73 | 0.67 |
| *sucrose_fraction_stalk* | SFS | 0.7 | 0.7 | 0.5 | 0.4 | 0.6 | 0.4 |
| *stress_factor_stalk* | SF | 0.8 | 0.7 | 0.9 | 0.9 | 1.0 | 0.9 |
| *sucrose_delay* | SD | 432 | 593 | 137 | 365 | 66 | 144 |
| *min_sstem_sucrose* | MSS | 597 | 402 | 1420 | 1356 | 811 | 1058 |
| *min_sstem_sucrose_redn* | MSSR | 14 | 16 | 2 | 1 | 15 | 4 |
| *tt_emerg_to_begcane* | EB | 1888 | 1301 | 1397 | 1887 | 1574 | 1272 |
| *tt_begcane_to_flowering* | BF | 6365 | 6400 | 6523 | 5782 | 5428 | 5421 |
| *tt_flowering_to_crop_end* | FC | 2002 | 2069 | 1794 | 2198 | 2014 | 2024 |
| *green_leaf_no* | GLN | 13 | 14 | 14 | 15 | 10 | 11 |
| | TLS1 | 6 | 1 | 3 | 2 | 1 | 3 |
| | TLS2 | 6 | 4 | 3 | 1 | 5 | 2 |
| *tillerf_leaf_size* | TLS3 | 5 | 4 | 1 | 5 | 6 | 2 |
| | TLS4 | 6 | 5 | 3 | 4 | 6 | 3 |
| | TLS5 | 4 | 5 | 5 | 5 | 4 | 5 |
| | TEC1 | 0.006 | 0.009 | 0.010 | 0.010 | 0.010 | 0.011 |
| | TEC2 | 0.006 | 0.007 | 0.011 | 0.013 | 0.014 | 0.008 |
| *transp_eff_cf* | TEC3 | 0.014 | 0.014 | 0.012 | 0.012 | 0.014 | 0.013 |
| | TEC4 | 0.014 | 0.014 | 0.014 | 0.009 | 0.013 | 0.013 |
| | TEC5 | 0.010 | 0.012 | 0.013 | 0.007 | 0.010 | 0.010 |
| | TEC6 | 0.008 | 0.010 | 0.010 | 0.011 | 0.007 | 0.010 |
| | RUE3 | 1.54 | 1.56 | 2.49 | 1.88 | 2.31 | 2.40 |
| *rue* | RUE4 | 2.07 | 2.46 | 2.48 | 2.26 | 2.37 | 2.33 |
| | RUE5 | 2.48 | 2.27 | 1.84 | 0.88 | 1.03 | 0.78 |

**Table S4.** Best estimated parameter ensembles obtained for the biomass and CDW of cultivar 02-2-058 from the emulators of experiments A, B1 and B2.

| Parameter Name | Code | KK3 | | | | | |
|---|---|---|---|---|---|---|---|
| | | A | | B1 | | B2 | |
| | | Biomass | CDW | Biomass | CDW | Biomass | CDW |
| | LS1 | 539 | 611 | 1566 | 1367 | 1872 | 1655 |
| *leaf_size* | LS2 | 63,615 | 65,516 | 62,686 | 51,527 | 66,206 | 25,114 |
| | LS3 | 58,572 | 39,043 | 47,681 | 30,198 | 26,536 | 27,588 |
| *cane_fraction* | CF | 0.66 | 0.72 | 0.65 | 0.70 | 0.65 | 0.67 |
| *sucrose_fraction_stalk* | SFS | 0.6 | 0.4 | 0.7 | 0.7 | 0.6 | 0.7 |
| *stress_factor_stalk* | SF | 1.0 | 1.0 | 0.9 | 1.0 | 0.9 | 0.3 |
| *sucrose_delay* | SD | 79 | 106 | 582 | 502 | 255 | 400 |
| *min_sstem_sucrose* | MSS | 471 | 580 | 432 | 604 | 631 | 1355 |
| *min_sstem_sucrose_redn* | MSSR | 20 | 16 | 19 | 19 | 6 | 3 |
| *tt_emerg_to_begcane* | EB | 1830 | 1545 | 1537 | 1226 | 1708 | 1729 |
| *tt_begcane_to_flowering* | BF | 6485 | 6405 | 5404 | 5462 | 6363 | 6515 |
| *tt_flowering_to_crop_end* | FC | 2199 | 2240 | 2138 | 2189 | 2005 | 2217 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *green_leaf_no* | GLN | 13 | 15 | 14 | 11 | 13 | 13 |
| | TLS1 | 1 | 4 | 5 | 4 | 5 | 5 |
| | TLS2 | 2 | 3 | 3 | 5 | 1 | 2 |
| *tillerf_leaf_size* | TLS3 | 5 | 2 | 1 | 1 | 2 | 6 |
| | TLS4 | 5 | 3 | 4 | 4 | 5 | 2 |
| | TLS5 | 5 | 5 | 3 | 2 | 2 | 5 |
| | TEC1 | 0.014 | 0.009 | 0.008 | 0.008 | 0.013 | 0.013 |
| | TEC2 | 0.006 | 0.006 | 0.007 | 0.010 | 0.010 | 0.006 |
| *transp_eff_cf* | TEC3 | 0.013 | 0.013 | 0.013 | 0.011 | 0.014 | 0.006 |
| | TEC4 | 0.014 | 0.014 | 0.014 | 0.014 | 0.013 | 0.013 |
| | TEC5 | 0.007 | 0.014 | 0.014 | 0.009 | 0.006 | 0.009 |
| | TEC6 | 0.007 | 0.009 | 0.011 | 0.008 | 0.007 | 0.007 |
| | RUE3 | 1.49 | 1.34 | 2.50 | 2.48 | 2.47 | 1.14 |
| *rue* | RUE4 | 2.29 | 2.49 | 2.46 | 2.48 | 1.66 | 2.50 |
| | RUE5 | 1.04 | 2.29 | 1.14 | 1.32 | 2.02 | 1.61 |