

## Supplementary Materials:

**Table S1.** Soil profile inputs at the target locations for DSSAT-CSM-CERES-Sorghum model. CNRA, NRIP, SINT and KOLD represent Bambey, Nioro du Rip, Sinthiou Malème and Kolda, respectively.

SLB	SLLL	SDUL	SSAT	SRGF	SSKS	SBDM	SLOC	SLCL	SLSI	SLNI	SLHW	SCEC
<b>CNRA</b>												
10	.028	.089	.4	1	-99	-99	.16	.4	17.1	.01	7.9	8
20	.039	.092	.403	1	-99	-99	.33	5.8	15.1	.03	7.8	9
30	.048	.103	.393	1	-99	-99	.215	.7	15	.01	7.7	9
40	.048	.103	.393	.54	-99	-99	.312	6.2	19.7	.03	6.9	10
50	.048	.103	.393	.54	-99	-99	.273	9.2	20.7	.03	6.6	18
<b>NRIP</b>												
10	.1	.162	.38	1	21	1.43	.211	.211	3.5	.04	6.1	-99
20	.12	.188	.373	.9	21	1.46	.211	.211	4.5	.05	6.0	-99
30	.133	.195	.358	.8	21	1.46	.211	.211	2.8	.05	5.9	-99
40	.12	.18	.37	.54	-99	1.48	.09	.09	1.7	.02	5.8	2.7
60	.13	.19	.36	.40	-99	1.47	.09	.09	1.6	.02	5.8	2.9
80	.14	.2	.38	.00	-99	1.57	.09	.09	1.7	.02	5.8	3.4
100	.15	.22	.4	.00	-99	1.44	.09	.09	1.8	.04	5.8	3.6
<b>SINT</b>												
10	.048	.097	.395	1	21	1.48	.211	2.7	4.2	.04	5.7	-99
20	.047	.095	.392	1	21	1.49	.272	2.6	4.2	.04	5.3	-99
30	.048	.094	.392	.607	21	1.49	.259	2.9	3.5	.04	5.5	-99
40	.102	.169	.383	.497	2.59	1.57	.208	12.4	7.8	.04	6.2	-99
50	.129	.203	.386	.407	2.59	1.56	.156	17.5	9.1	.04	6.7	-99
60	.138	.209	.38	.333	.43	1.58	.096	20.2	9	.06	6.4	-99
80	.173	.244	.384	0	.43	1.57	.096	27.2	7	.06	6.4	-99
100	.178	.251	.384	0	.43	1.57	.092	28.2	7.5	.04	6.4	-99
120	.162	.234	.38	0	.43	1.58	.092	25.1	7.7	.04	6.4	-99
140	.167	.243	.384	0	.43	1.57	.087	26.1	9.6	.04	6.4	-99
160	.048	.098	.416	0	21	1.48	.087	2.2	4	.04	6.4	-99
<b>KOLD</b>												
20	.113	.206	.331	1	2.59	1.34	.8	19	27	-99	5.1	4
40	.089	.165	.278	.9	2.59	1.46	.715	18	26	-99	5	4
60	.088	.16	.301	.2	2.59	1.48	.22	18	26	-99	5.3	3.8
80	.08	.151	.293	.0	2.59	1.51	.2	16	26	-99	5.4	3.5
100	.053	.101	.298	0	2.59	1.54	.154	15	26	-99	5.4	3
120	.026	.348	.456	0	0.06	1.37	.320	45	11	-99	5	4

SLB: Depth, base of layer(cm)

SLLL: Soil water content at wilting point ( $\text{cm}^3 \text{cm}^{-3}$ )

SDUL: Soil water content at field capacity ( $\text{cm}^3 \text{cm}^{-3}$ )

SSAT: Soil water content at saturation ( $\text{cm}^3 \text{cm}^{-3}$ )

SRGF: Root growth factor, 0.0 to 1.0

SSKS: Saturated hydraulic conductivity ( $\text{cm h}^{-1}$ )

SBDM: Bulk density ( $\text{g cm}^{-3}$ )

SLOC: Organic carbon (%)

SLCL: Clay ( $<0.002 \text{ mm}$ ) (%)

SLSI: Silt ( $0.05 \text{ to } 0.002 \text{ mm}$ ) (%)

SLCF: Coarse fraction ( $>2 \text{ mm}$ ) (%)

SLNI: Total nitrogen (%)

SLHW: pH in water

SCEC: Cation exchange capacity ( $\text{cmol kg}^{-1}$ )

\*-99 indicates that no measured data available.

**Table S2.** Calibrated genetic coefficient of CSM-CERES-Sorghum model for Fadda sorghum cultivar in Senegal

P1	P2	P2O	P2R	PANTH	P3	P4	P5	PHINT	G1	G2
200	300	12.6	655	617.5	185	81.5	380	49	15	3

P1 [ $^{\circ}\text{C day}$ ]: Potential duration from emergence to end of juvenile phase

P2 [ $^{\circ}\text{C day}$ ]: Potential duration from end of juvenile phase to panicle initiation

P2O [h]: Critical daylength above which development slows (short day response)

P2R [ $^{\circ}\text{C day}$ ]: Photoperiod sensitivity as the extent to which development is delayed for each hour of photoperiod above P2O

PANTH [ $^{\circ}\text{C day}$ ]: Duration from panicle initiation to anthesis

P3 [ $^{\circ}\text{C day}$ ]: Duration from end of flag leaf expansion to anthesis

P4 [ $^{\circ}\text{C day}$ ]: Duration from anthesis to onset of grain filling

P5 [ $^{\circ}\text{C day}$ ]: Duration of grain-filling phase (onset of grain filling to physiological maturity)

PHINT [ $^{\circ}\text{C day leaf}^{-1}$ ]: Phyllochron interval (the interval in thermal time between successive leaf tip appearances)

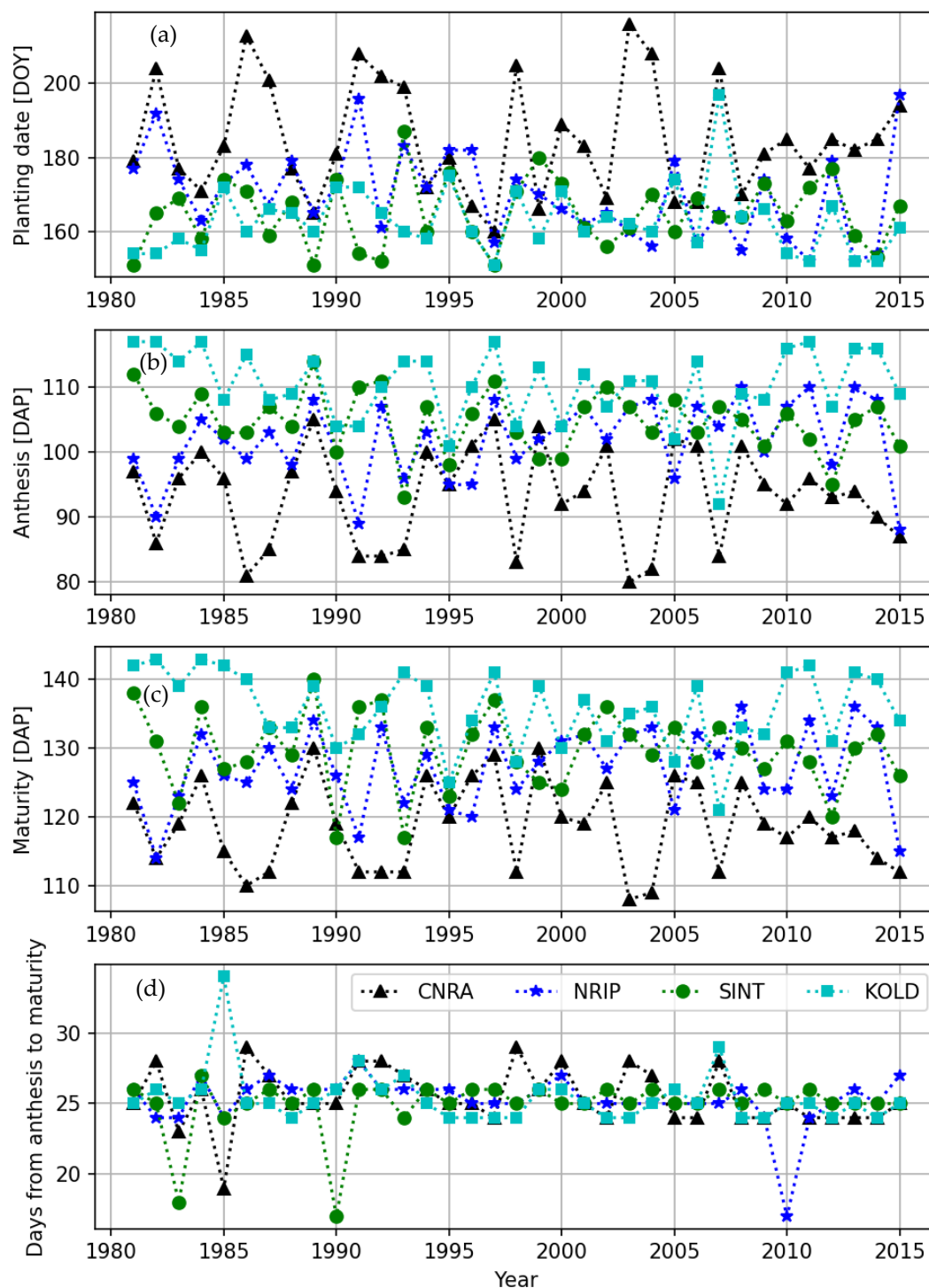
G1 [-]: Scaler for relative leaf size.

G2 [-]: Scaler for partitioning of assimilates to the panicle (head).

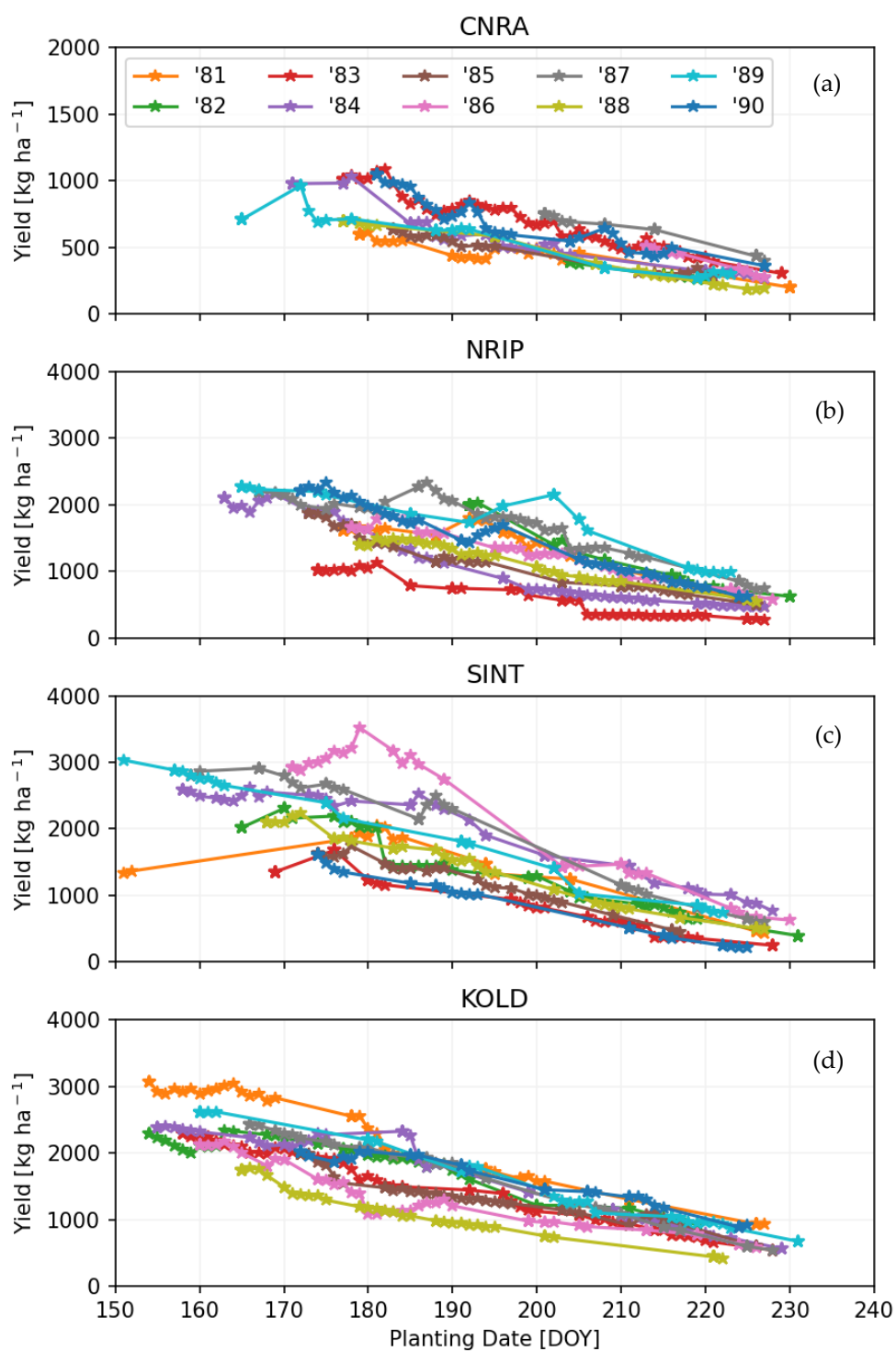
\*See more details on DSSAT-CERES-Sorghum model and genetic coefficients in White et al. [43] and the selected cultivars in Ganyo et al. [44]

**Table S3.** Summary statistics of estimated planting dates for each onset definition

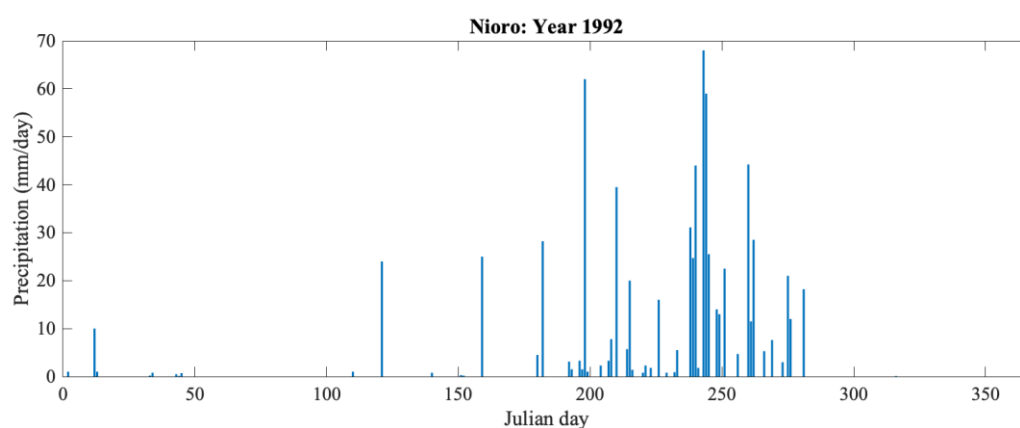
	Onset Definition	Mean	Stdev	Min	max	Percentiles				
						10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>
<b>CNRA</b>	ANACIM	191	15	167	220	172	178	192	201	212
	BM	187	15	161	218	168	175	186	200	206
	AutoP(151)	185	16	160	216	167	172	182	200	207
	AutoP(166)	185	15	166	216	168	172	182	200	207
	Optimal	189	14	165	220	170	179	185	201	208
<b>NRIP</b>	ANACIM	175	12	152	195	158	165	177	185	190
	BM	172	14	123	193	156	163	175	181	184
	AutoP(151)	170	12	152	197	155	161	170	179	183
	AutoP(166)	174	9	166	197	166	167	173	179	184
	Optimal	178	15	153	214	160	167	177	186	197
<b>SINT</b>	ANACIM	168	17	139	214	148	157	166	181	188
	BM	159	14	131	183	141	150	160	168	176
	AutoP(151)	165	9	151	187	152	159	164	172	175
	AutoP(166)	170	5	166	187	166	166	170	173	177
	Optimal	170	10	151	200	159	162	171	177	181
<b>KOLD</b>	ANACIM	161	14	130	191	142	153	160	172	174
	BM	160	14	131	192	141	152	159	168	174
	AutoP(151)	163	9	151	197	153	158	160	167	172
	AutoP(166)	169	6	166	197	166	166	167	171	173
	Optimal	166	9	152	197	156	160	165	170	176



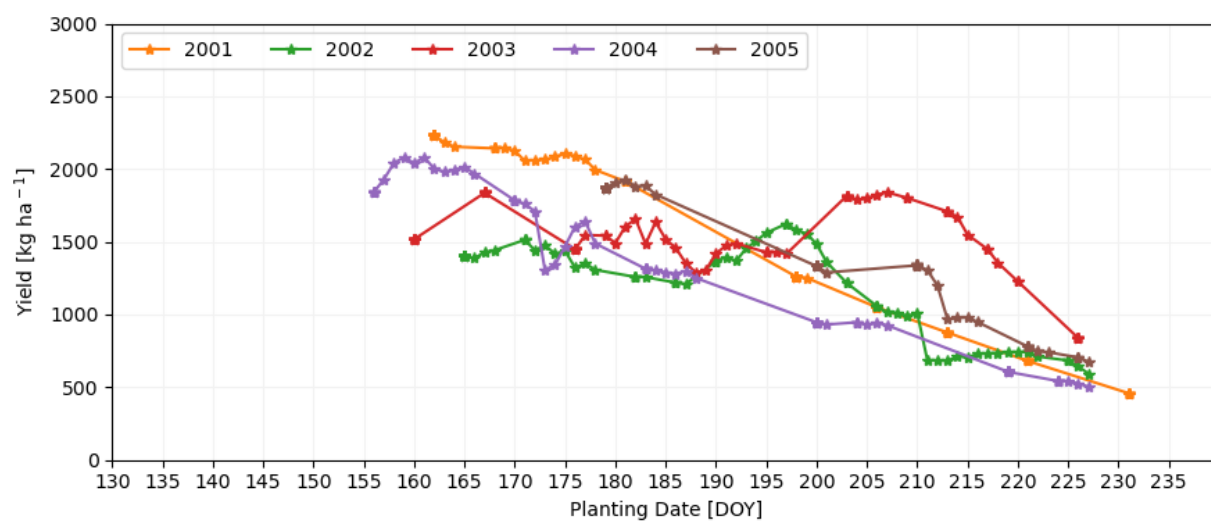
**Figure S1.** Inter-annual variation of simulated soil moisture-based planting dates (a), anthesis dates (b), maturity dates (c), and duration from anthesis to maturity (d) of Fadda sorghum cultivars at four target locations.



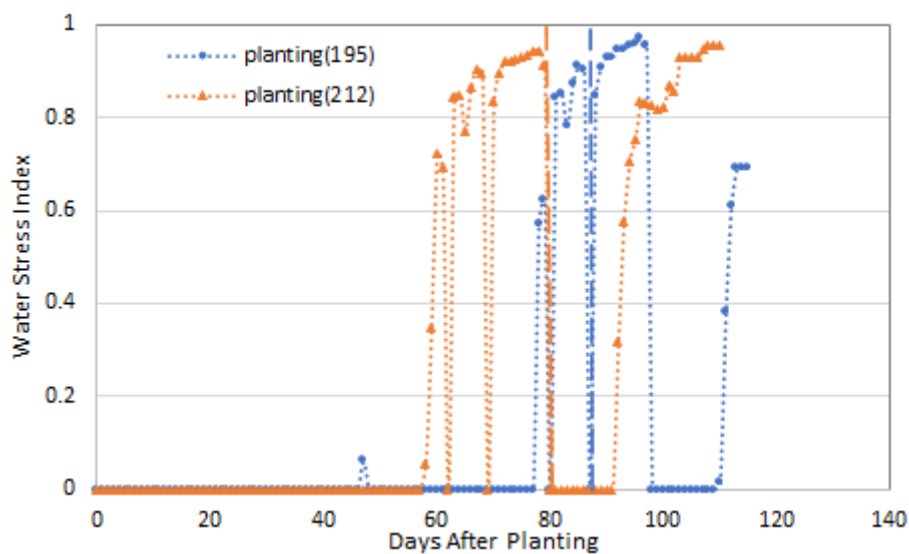
**Figure S2.** Simulated sorghum yield with automatic planting dates determined by shifting planting windows day by day, for 4 target locations: CNRA (a), NRIP (b), SINT(c) and KOLD (d) represent Bambey, Niore du Rip, Sinthiou Malème and Kolda, respectively. Different colors represent different years from 1981 to 1990.



**Figure S3.** Rainfall in NRIP in 1992.



**Figure S4.** Simulated sorghum yield with automatic planting dates determined by shifting planting windows day by day at NRIP for selected years (2001-2005).



**Figure S5.** Simulated water stress indices in NRIP with semi-optimal planting onset dates for two cases: planting on DOY 195 vs. DOY 212 in 2003. Note that the water stress index is computed as 1 minus water deficiency, where water deficiency is the ratio of supply to potential demand. The higher water stress index indicates less water supply for root water uptake hindering crop growth. Vertical dashed lines indicate anthesis dates.