

Table S1. Description of image features, number of flights, number of image features and dimensions of image chips for the three imaging approaches tested.

Model name	Image Features	Type of features	N features	N flights	Image chip size ⁴
RGB	RGB ¹	Spectral	3	1-10	40 x 40 x 3-30
MS	RGB, Re ² , NIR ²	Spectral	5	1-10	40 x 40 x 5-50
CSM_MS	RGB, Re, NIR, CSM ³	Spectral and geometric	6	1-10	40 x 40 x 6-60

¹R=red, G = green, B=blue spectral bands.

²Re = red edge, NIR=near-infrared spectral bands.

³CSM = Crop surface model.

⁴Image chip size = N pixels (width) x N pixels (height) x Depth (N flights x N features).

Table S2. Description of the 138 CNN models implemented according to combinations of UAV-based image features, CNN architectures, and target traits.

Model name	Image features	Trait	Model architecture	Time length	Flights DOYs included
RGB_TP_205 (1)	RGB	Flowering time	2D-CNN	1	205
MS_TP_205 (1)	RGB, Re, NIR	Flowering time	2D-CNN	1	205
CSM_MS_TP_205 (1)	RGB, Re, NIR, CSM	Flowering time	2D-CNN	1	205
RGB_TP_221 (1)	RGB	Flowering time	2D-CNN	1	221
MS_TP_221 (1)	RGB, Re, NIR	Flowering time	2D-CNN	1	221
CSM_MS_TP_221 (1)	RGB, Re, NIR, CSM	Flowering time	2D-CNN	1	221
RGB_TP_247 (1)	RGB	Flowering time	2D-CNN	1	247
MS_TP_247 (1)	RGB, Re, NIR	Flowering time	2D-CNN	1	247
CSM_MS_TP_247 (1)	RGB, Re, NIR, CSM	Flowering time	2D-CNN	1	247
RGB_TP_262 (1)	RGB	Flowering time	2D-CNN	1	262
MS_TP_262 (1)	RGB, Re, NIR	Flowering time	2D-CNN	1	262
CSM_MS_TP_262 (1)	RGB, Re, NIR, CSM	Flowering time	2D-CNN	1	262
RGB_TP_279 (1)	RGB	Flowering time	2D-CNN	1	279
MS_TP_279 (1)	RGB, Re, NIR	Flowering time	2D-CNN	1	279
CSM_MS_TP_279 (1)	RGB, Re, NIR, CSM	Flowering time	2D-CNN	1	279
RGB_TP_310 (1)	RGB	Flowering time	2D-CNN	1	310
MS_TP_310 (1)	RGB, Re, NIR	Flowering time	2D-CNN	1	310
CSM_MS_TP_310 (1)	RGB, Re, NIR, CSM	Flowering time	2D-CNN	1	310
RGB_TP_332 (1)	RGB	Flowering time	2D-CNN	1	332

MS_TP_332 (1)	RGB, Re, NIR	Flowering time	2D-CNN	1	332
CSM_MS_TP_332 (1)	RGB, Re, NIR, CSM	Flowering time	2D-CNN	1	332
RGB_TR_262:279 (2)	RGB	Flowering time	3D-CNN	2	262,279
MS_TR_262:279 (2)	RGB, Re, NIR	Flowering time	3D-CNN	2	262,279
CSM_MS_TR_262:279 (2)	RGB, Re, NIR, CSM	Flowering time	3D-CNN	2	262,279
RGB_TR_247:279 (3)	RGB	Flowering time	3D-CNN	3	247,262,279
MS_TR_247:279 (3)	RGB, Re, NIR	Flowering time	3D-CNN	3	247,262,279
CSM_MS_TP_247:279 (3)	RGB, Re, NIR, CSM	Flowering time	3D-CNN	3	247,262,279
RGB_TR_221:279 (4)	RGB	Flowering time	3D-CNN	4	221,247,262,279
MS_TR_221:279 (4)	RGB, Re, NIR	Flowering time	3D-CNN	4	221,247,262,279
CSM_MS_TP_221:279 (4)	RGB, Re, NIR, CSM	Flowering time	3D-CNN	4	221,247,262,279
RGB_TR_247:310 (4)	RGB	Flowering time	3D-CNN	4	247,262,279,310
MS_TR_247:310 (4)	RGB, Re, NIR	Flowering time	3D-CNN	4	247,262,279,310
CSM_MS_TP_247:310 (4)	RGB, Re, NIR, CSM	Flowering time	3D-CNN	4	247,262,279,310
RGB_TR_221:310 (5)	RGB	Flowering time	3D-CNN	5	221,247,262,279,310
MS_TR_221:310 (5)	RGB, Re, NIR	Flowering time	3D-CNN	5	221,247,262,279,310
CSM_MS_TP_221:310 (5)	RGB, Re, NIR, CSM	Flowering time	3D-CNN	5	221,247,262,279,310
RGB_TP_157 (1)	RGB	Culm stem length	2D-CNN	1	157
MS_TP_157 (1)	RGB, Re, NIR	Culm stem length	2D-CNN	1	157
CSM_MS_TP_157 (1)	RGB, Re, NIR, CSM	Culm stem length	2D-CNN	1	157
RGB_TP_174 (1)	RGB	Culm stem length	2D-CNN	1	174
MS_TP_174 (1)	RGB, Re, NIR	Culm stem length	2D-CNN	1	174
CSM_MS_TP_174 (1)	RGB, Re, NIR, CSM	Culm stem length	2D-CNN	1	174
RGB_TP_190 (1)	RGB	Culm stem length	2D-CNN	1	190
MS_TP_190 (1)	RGB, Re, NIR	Culm stem length	2D-CNN	1	190
CSM_MS_TP_190 (1)	RGB, Re, NIR, CSM	Culm stem length	2D-CNN	1	190
RGB_TP_205 (1)	RGB	Culm stem length	2D-CNN	1	205
MS_TP_205 (1)	RGB, Re, NIR	Culm stem length	2D-CNN	1	205
CSM_MS_TP_205 (1)	RGB, Re, NIR, CSM	Culm stem length	2D-CNN	1	205
RGB_TP_221 (1)	RGB	Culm stem length	2D-CNN	1	221
MS_TP_221 (1)	RGB, Re, NIR	Culm stem length	2D-CNN	1	221
CSM_MS_TP_221 (1)	RGB, Re, NIR, CSM	Culm stem length	2D-CNN	1	221
RGB_TP_247 (1)	RGB	Culm stem length	2D-CNN	1	247
MS_TP_247 (1)	RGB, Re, NIR	Culm stem length	2D-CNN	1	247
CSM_MS_TP_247 (1)	RGB, Re, NIR, CSM	Culm stem length	2D-CNN	1	247
RGB_TP_262 (1)	RGB	Culm stem length	2D-CNN	1	262
MS_TP_262 (1)	RGB, Re, NIR	Culm stem length	2D-CNN	1	262
CSM_MS_TP_262 (1)	RGB, Re, NIR, CSM	Culm stem length	2D-CNN	1	262

RGB_TP_279 (1)	RGB	Culm stem length	2D-CNN	1	279
MS_TP_279 (1)	RGB, Re, NIR	Culm stem length	2D-CNN	1	279
CSM_MS_TP_279 (1)	RGB, Re, NIR, CSM	Culm stem length	2D-CNN	1	279
RGB_TP_310 (1)	RGB	Culm stem length	2D-CNN	1	310
MS_TP_310 (1)	RGB, Re, NIR	Culm stem length	2D-CNN	1	310
CSM_MS_TP_310 (1)	RGB, Re, NIR, CSM	Culm stem length	2D-CNN	1	310
RGB_TP_332 (1)	RGB	Culm stem length	2D-CNN	1	332
MS_TP_332 (1)	RGB, Re, NIR	Culm stem length	2D-CNN	1	332
CSM_MS_TP_332 (1)	RGB, Re, NIR, CSM	Culm stem length	2D-CNN	1	332
RGB_TR_247_332 (2)	RGB	Culm stem length	3D-CNN	2	247,332
MS_TR_247_332 (2)	RGB, Re, NIR	Culm stem length	3D-CNN	2	247,332
CSM_MS_TR_247_332 (2)	RGB, Re, NIR, CSM	Culm stem length	3D-CNN	2	247,332
RGB_TR_174:332 (3)	RGB	Culm stem length	3D-CNN	3	174,247,332
MS_TR_174:332 (3)	RGB, Re, NIR	Culm stem length	3D-CNN	3	174,247,332
CSM_MS_TP_174:332 (3)	RGB, Re, NIR, CSM	Culm stem length	3D-CNN	3	174,247,332
RGB_TR_157:190 (3)	RGB	Culm stem length	3D-CNN	3	157,174,190
MS_TR_157:190 (3)	RGB, Re, NIR	Culm stem length	3D-CNN	3	157,174,190
CSM_MS_TP_157:190 (3)	RGB, Re, NIR, CSM	Culm stem length	3D-CNN	3	157,174,190
RGB_TR_205:247 (3)	RGB	Culm stem length	3D-CNN	3	205,221,247
MS_TR_205:247 (3)	RGB, Re, NIR	Culm stem length	3D-CNN	3	205,221,247
CSM_MS_TP_205:247 (3)	RGB, Re, NIR, CSM	Culm stem length	3D-CNN	3	205,221,247
RGB_TR_279:332 (3)	RGB	Culm stem length	3D-CNN	3	279,310,332
MS_TR_279:332 (3)	RGB, Re, NIR	Culm stem length	3D-CNN	3	279,310,332
CSM_MS_TP_279:332 (3)	RGB, Re, NIR, CSM	Culm stem length	3D-CNN	3	279,310,332
RGB_TR_247:332 (5)	RGB	Culm stem length	3D-CNN	5	247,262,279,310,332
MS_TR_247:332 (5)	RGB, Re, NIR	Culm stem length	3D-CNN	5	247,262,279,310,332
CSM_MS_TP_247:332 (5)	RGB, Re, NIR, CSM	Culm stem length	3D-CNN	5	247,262,279,310,332
RGB_TR_157:332 (10)	RGB	Culm stem length	3D-CNN	10	157,174,190,205,221,247,262,279,310,332
MS_TR_157:332 (10)	RGB, Re, NIR	Culm stem length	3D-CNN	10	157,174,190,205,221,247,262,279,310,332
CSM_MS_TP_157:332 (10)	RGB, Re, NIR, CSM	Culm stem length	3D-CNN	10	157,174,190,205,221,247,262,279,310,332
RGB_TP_157 (1)	RGB	Biomass yield	2D-CNN	1	157
MS_TP_157 (1)	RGB, Re, NIR	Biomass yield	2D-CNN	1	157
CSM_MS_TP_157 (1)	RGB, Re, NIR, CSM	Biomass yield	2D-CNN	1	157
RGB_TP_174 (1)	RGB	Biomass yield	2D-CNN	1	174
MS_TP_174 (1)	RGB, Re, NIR	Biomass yield	2D-CNN	1	174
CSM_MS_TP_174 (1)	RGB, Re, NIR, CSM	Biomass yield	2D-CNN	1	174
RGB_TP_190 (1)	RGB	Biomass yield	2D-CNN	1	190
MS_TP_190 (1)	RGB, Re, NIR	Biomass yield	2D-CNN	1	190

CSM_MS_TP_190 (1)	RGB, Re, NIR, CSM	Biomass yield	2D-CNN	1	190
RGB_TP_205 (1)	RGB	Biomass yield	2D-CNN	1	205
MS_TP_205 (1)	RGB, Re, NIR	Biomass yield	2D-CNN	1	205
CSM_MS_TP_205 (1)	RGB, Re, NIR, CSM	Biomass yield	2D-CNN	1	205
RGB_TP_221 (1)	RGB	Biomass yield	2D-CNN	1	221
MS_TP_221 (1)	RGB, Re, NIR	Biomass yield	2D-CNN	1	221
CSM_MS_TP_221 (1)	RGB, Re, NIR, CSM	Biomass yield	2D-CNN	1	221
RGB_TP_247 (1)	RGB	Biomass yield	2D-CNN	1	247
MS_TP_247 (1)	RGB, Re, NIR	Biomass yield	2D-CNN	1	247
CSM_MS_TP_247 (1)	RGB, Re, NIR, CSM	Biomass yield	2D-CNN	1	247
RGB_TP_262 (1)	RGB	Biomass yield	2D-CNN	1	262
MS_TP_262 (1)	RGB, Re, NIR	Biomass yield	2D-CNN	1	262
CSM_MS_TP_262 (1)	RGB, Re, NIR, CSM	Biomass yield	2D-CNN	1	262
RGB_TP_279 (1)	RGB	Biomass yield	2D-CNN	1	279
MS_TP_279 (1)	RGB, Re, NIR	Biomass yield	2D-CNN	1	279
CSM_MS_TP_279 (1)	RGB, Re, NIR, CSM	Biomass yield	2D-CNN	1	279
RGB_TP_310 (1)	RGB	Biomass yield	2D-CNN	1	310
MS_TP_310 (1)	RGB, Re, NIR	Biomass yield	2D-CNN	1	310
CSM_MS_TP_310 (1)	RGB, Re, NIR, CSM	Biomass yield	2D-CNN	1	310
RGB_TP_332 (1)	RGB	Biomass yield	2D-CNN	1	332
MS_TP_332 (1)	RGB, Re, NIR	Biomass yield	2D-CNN	1	332
CSM_MS_TP_332 (1)	RGB, Re, NIR, CSM	Biomass yield	2D-CNN	1	332
RGB_TR_247_332 (2)	RGB	Biomass yield	3D-CNN	2	247,332
MS_TR_247_332 (2)	RGB, Re, NIR	Biomass yield	3D-CNN	2	247,332
CSM_MS_TR_247_332 (2)	RGB, Re, NIR, CSM	Biomass yield	3D-CNN	2	247,332
RGB_TR_174:332 (3)	RGB	Biomass yield	3D-CNN	3	174,247,332
MS_TR_174:332 (3)	RGB, Re, NIR	Biomass yield	3D-CNN	3	174,247,332
CSM_MS_TP_174:332 (3)	RGB, Re, NIR, CSM	Biomass yield	3D-CNN	3	174,247,332
RGB_TR_157:190 (3)	RGB	Biomass yield	3D-CNN	3	157,174,190
MS_TR_157:190 (3)	RGB, Re, NIR	Biomass yield	3D-CNN	3	157,174,190
CSM_MS_TP_157:190 (3)	RGB, Re, NIR, CSM	Biomass yield	3D-CNN	3	157,174,190
RGB_TR_205:247 (3)	RGB	Biomass yield	3D-CNN	3	205,221,247
MS_TR_205:247 (3)	RGB, Re, NIR	Biomass yield	3D-CNN	3	205,221,247
CSM_MS_TP_205:247 (3)	RGB, Re, NIR, CSM	Biomass yield	3D-CNN	3	205,221,247
RGB_TR_279:332 (3)	RGB	Biomass yield	3D-CNN	3	279,310,332
MS_TR_279:332 (3)	RGB, Re, NIR	Biomass yield	3D-CNN	3	279,310,332
CSM_MS_TP_279:332 (3)	RGB, Re, NIR, CSM	Biomass yield	3D-CNN	3	279,310,332
RGB_TR_247:332 (5)	RGB	Biomass yield	3D-CNN	5	247,262,279,310,332

MS_TR_247:332 (5)	RGB, Re, NIR	Biomass yield	3D-CNN	5	247,262,279,310,332
CSM_MS_TP_247:332 (5)	RGB, Re, NIR, CSM	Biomass yield	3D-CNN	5	247,262,279,310,332
RGB_TR_157:332 (10)	RGB	Biomass yield	3D-CNN	10	157,174,190,205,221,247,262,279,310,332
MS_TR_157:332 (10)	RGB, Re, NIR	Biomass yield	3D-CNN	10	157,174,190,205,221,247,262,279,310,332
CSM_MS_TP_157:332 (10)	RGB, Re, NIR, CSM	Biomass yield	3D-CNN	10	157,174,190,205,221,247,262,279,310,332
