

TABLE S1 | Initial soil parameters used for DSSAT model calibration.

Site	Depth m	θ $\text{m}^3 \text{m}^{-3}$	$\text{NO}_3\text{-N}$ mg kg^{-1}	Water table depth m	Slope %
Lamberton	0.0-0.5	0.35	6.5	1.5	2.0
	0.5-1.2	0.30	2.0		
Waseca	0.0-0.5	0.34	7.8	1.2	2.0
	0.5-1.2	0.31	2.1		
Crookston	0.0-0.5	0.29	4.5	3.0	2.0
	0.5-1.2	0.30	1.8		

TABLE S2 | IWG measured parameters used for Model Calibration.

Parameter	Value
Grains spike ⁻¹	31.9
Maximum seed weight (g)	0.02
Maximum size of full leaf (cm^2)	24.7
Plant height (m)	1.5
Rooting depth (m)	1.2
Maximum leaves per stem	8.0
Row spacing (cm)	15
Planting depth (cm)	5
Planting method	Dry seed
Planting date	August 2011*, May 2012**
Mowing	End-August 2012
Harvesting date	Mid-August 2013, 2014, 2015

*, Lamberton and Waseca; ** Crookston

TABLE S3 | IWG plant population used for Model Calibration.

Site	N_0	N_1	N_2
Lamberton	750	820	850
Waseca	700	770	810
Crookston	840	880	920

Average across four repeats

TABLE S4 | IWG Cultivar and Eco file parameters optimized for Model Calibration.

File	Parameter	Default	Optimized
Cultivar	! CSDL, Critical short-day length below which reproductive dev. is affected	12.5	11.5
	PPSEN, Slope of the relative response of development to photoperiod with time	0.2	0.5
	EM-FL, Time between plant emergence and flower appearance (R1)	99	90
	LFMAX, Maximum leaf photosynthesis rate at 30 C	1.92	1.8
	SLAVR, Specific leaf area of cultivar under standard growth conditions	270	180
	SIZLF, Maximum size of full leaf (cm2)	14.7	45
	WTPSD, Maximum weight per seed (g)	0.02	0.02
ECO	THVAR, Min. rate of reproductive dev. under short days and optimal temperature	1	0.1
	TRIFL, Rate of appearance of leaves on the main-stem	0.12	0.10
	RHGHT, Relative height of this ecotype in comparison to the standard height/node	1	2
	RDRMT, Relative dormancy sensitivity of this cultivar to daylength partitioning	0.375	0.175

TABLE S5 | Model parameter names, definitions, initial values for Marandu palisade grass (Pequeno et al., 2018) and calibrated values for plant composition, phenology, and productivity (photosynthesis and respiration) of IWG dataset.

Name	Definition	Initial	Optimized values
PRO- G	“Normal growth” protein concentrations of tissue (leaf = LF, root = RT, stem = ST, storage organ = SR)	0.110, 0.040, 0.070, 0.064	0.150 , 0.040, 0.070, 0.064
PRO- I	“Maximum” protein concentrations of tissue (leaf = LF, root = RT, stem = ST, storage organ = SR).	0.220, 0.110, 0.101, 0.092	0.220, 0.110, 0.120 , 0.092
TB, TO1, TO2, TM	Base temperature (TB), first optimum (TO1), second optimum (TO2), and maximum temperature for vegetative development (TM) (°C)	9.0, 32.0, 40.0, 45.0	8.9, 30.0 , 40.0, 45.0
RES30C	Constant (g CH ₂ O per g of dry weight/h) describing maintenance respiration as a function of total crop dry weight (minus oil, protein, and starch in the seed). Temperature dependent	3.5E-05	3.0 x10 ⁻⁴
MRSWITCH	Respiration: M = Mass-based/original CROPGRO code or P = Protein-based	P	M
FNPGN (1-2)	Leaf nitrogen effect on PG or FNPGN (4) and TYPPGN-A two-sided quadratic curve describing leaf photosynthesis response to leaf N concentration. Increases from zero at the minimum leaf N concentration to maximum at the maximum leaf N concentration.	0.75, 3.00	0.80, 4.00
R30C2	Constant, g CH ₂ O per g of photosynthate CH ₂ O per hour describing maintenance respiration as a function of canopy photosynthesis. Temperature dependent	0.0029	0.0024

TABLE S6| Model parameter names, definitions, initial values for Marandu palisade grass (Pequeno et al., 2018) and calibrated values (IWG) for temperature, solar radiation and photoperiod effects on vegetative partitioning, specific leaf area, and photosynthesis.

Name	Definition	Initial	Optimized values
XLFEST	Leaf number or vegetative stage at which the partitioning is defined	0.0, 1.5, 2.0, 3.0, 5.0, 7.0, 30.0, 40.0	0.0, 2.0, 3.0, 5.0 , 7.0, 10.0 , 30.0, 40.0
YLFEST	Describes dry-matter partitioning to leaf among vegetative tissue only, as a function of vegetative stage (fraction)	0.8, 0.8, 0.72, 0.63, 0.52, 0.51, 0.5, 0.5	0.8, 0.8, 0.72, 0.65 , 0.55, 0.53, 0.53 , 0.53
YTEST	Describes dry-matter partitioning to stem among vegetative tissue only, as a function of vegetative stage (fraction)	0.1, 0.1, 0.14, 0.17, 0.32, 0.36, 0.35, 0.35	0.1, 0.1, 0.14, 0.20 , 0.30, 0.33, 0.33 , 0.32
SREST	Describes dry-matter partitioning to storage among vegetative tissue only, as a function of vegetative stage (fraction)	0.01, 0.01, 0.03, 0.04, 0.04, 0.04, 0.04, 0.04	0.01, 0.01, 0.03, 0.04, 0.04, 0.04, 0.04, 0.04
SLAVR	Specific leaf area of cultivar under standard growth conditions (cm ² /g)	190	200
SLAMAX	SLAMAX is the (thinnest) leaves under low light (cm ² /g)	340	355
SLAMIN	SLAMIN is the (thickest) leaves under high light (cm ² /g)	139	130
FNPGL (1,2)	Relative effect of minimum night temperature on next day's leaf light-saturated photosynthesis rate. Quadratic shape, first value defines base (0.0) and second defines maximum (1.0) (°C)	5.1, 22.2	5.0, 17.0
XLMAXT (2,3)	Relative rate of photosynthetic electron transport in response to temperature, linear from base (0.0) to maximum (1.0) (°C)	6.2, 40.2	8.6, 35.5
XSLATM (3,4)	Relative temperature effect on specific leaf area of newly formed leaves, °C (x vs. y pair)	10.3, 24.2	11.7, 26.0
YSLATM (3,4)	Relative temperature effect on specific leaf area of newly formed leaves, fraction reduction (x vs. y pair)	0.39, 1.00	0.39, 1.00
FNPTD (2,3)	Daylength effect on partitioning (hr)	12.0, 16.0	10.0, 14.0
FNPMD (1,3)	Daylength effect on mobilization (hr)	7.8, 12.0, 0.62	9.6, 13.0, 0.50
RDRMT	Relative dormancy sensitivity, daylength effect on partitioning	0.475	0.40
RDRMM	Relative dormancy sensitivity, daylength effect on mobilization	0.850	0.70

TABLE S7 | Model parameter names, definitions, initial values for Marandu palisade grass (Pequeno et al., 2018) and calibrated values (IWG) for carbon and nitrogen mining, root, and leaf growth parameters.

Name	Definition	Initial	Optimized
Name	Definition	Marandu	IWG
CMOBSRN	Minimum daily rate of CH ₂ O mobilization from storage (fraction)	0.02	0.02
CMOBSRX	Maximum daily rate of CH ₂ O mobilization from storage (fraction)	0.072	0.050
NMOBSRN	Minimum daily rate on N mobilization from storage (fraction)	0.01	0.01
NMOBSRX	Maximum daily rate on N mobilization from storage (fraction)	0.068	0.060
ALPHSR	Fraction of new storage tissue growth that is available CH ₂ O (fraction)	0.20	0.20
CADPV	Maximum fraction of photoassimilate available that can be allocated to CH ₂ O refill during non-stress conditions	0.356	0.42
LRMOB (3,4)	Leaf area index effect on mobilization (most rapid to least rapid)	0.41, 2.75	0.43, 2.0
CRREF (2,3,4)	Carbohydrate status effect on refilling of storage tissue CH ₂ O pool	0.33, 0.81, 0.29	0.30, 0.81, 0.29
LRREF (1,2)	LAI effect on refilling of storage tissue CH ₂ O pool (least to most rapid)	0.68, 2.58	0.65, 2.40
PRREF (1,2)	Canopy photosynthesis effect on refilling of storage tissue CH ₂ O	0.12, 0.38	0.20, 0.40
CMOBMX	Maximum mobilization of CH ₂ O from vegetative tissues, fraction of available CH ₂ O pool per day	0.05	0.05
NMOBMX	Maximum mobilization of protein from vegetative tissues, fraction of available protein pool per day	0.08	0.08
CADSRF	Fraction of carbohydrate reserves that are added to storage organs	0.439	0.439
NRCVR	Minimum fraction applied to N concentrations at physiological maturity	0.15	0.19
FINREF		150.0	150.0
SLAREF	specific leaf area of crop species standard	190.0	190.0
SIZREF	Species dependent leaf size	2.00	5.00
SLAMAX	The max. specific leaf area in low light	340.0	160.0
XSLATM(3)	Temperature values (DP)	10.3	06.3
XSLATM (4)	"	24.2	20.2
XSLATM (5)	"	60.0	50.0
RTDEPI	Rooting depth parameter	20.0	55.0
RTSDF	The maximum fraction of root length senesced when water content falls below 25% of extractable soil water.	0.02	0.01

TABLE S8 | Senescence parameter names, definitions, initial values (bahiagrass) and optimized values (IWG).

Name	Definition	Initial	Optimized
LFSEN	Minimum daily rate of CH ₂ O mobilization from storage (fraction)	0.01	0.01
RTSEN	Maximum daily rate of CH ₂ O mobilization from storage (fraction)	0.008	0.008
ICMP	Minimum daily rate on N mobilization from storage (fraction)	1.17	1.17
TCMP	Maximum daily rate on N mobilization from storage (fraction)	13.1	13.1
PORPT	Maximum mobilization of protein from vegetative tissues, fraction of available protein pool per day	0.27	0.27
SENSR	Fraction of carbohydrate reserves that are added to storage organs (remainder is allocated to stem and leaf)	0.011	0.08

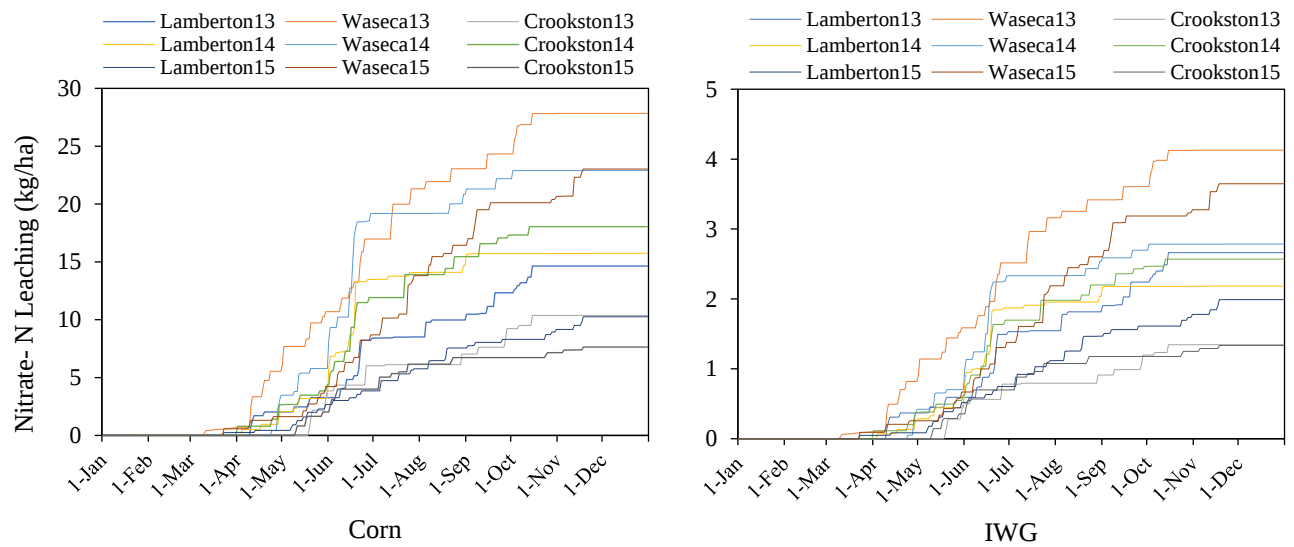


Figure S1. Nitrate leaching in corn and IWG at Lamberton, Waseca and Crookston during 2013 (13), 2014 (14) and 2015 (15)

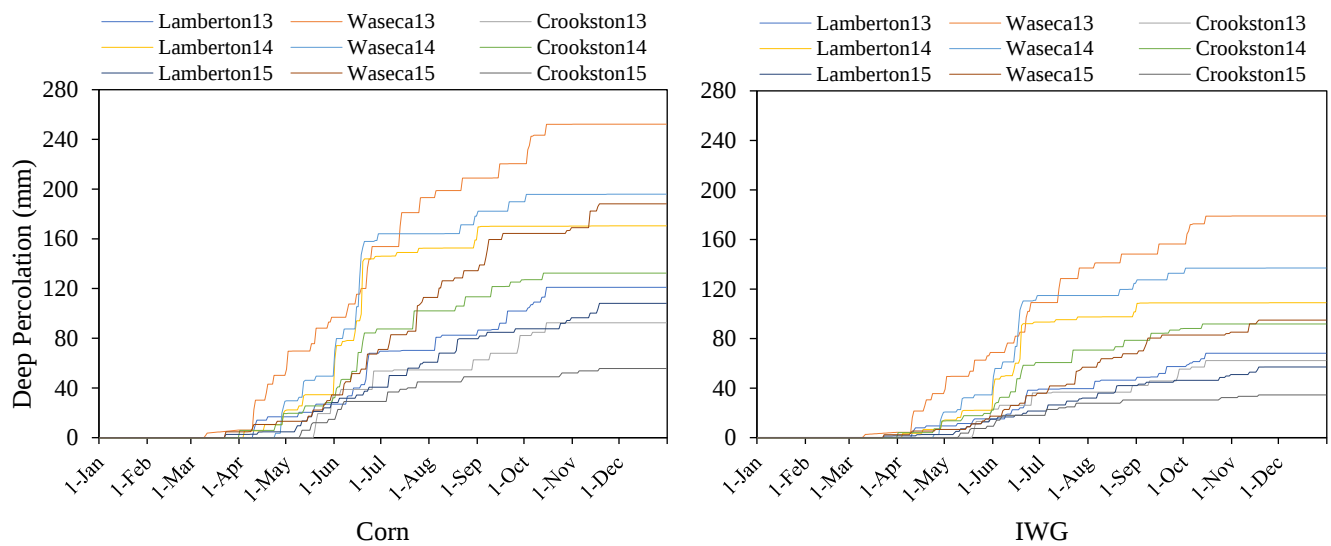


Figure S2. Deep percolation in corn and IWG at Lamberton, Waseca and Crookston during 2013 (13), 2014 (14) and 2015 (15)