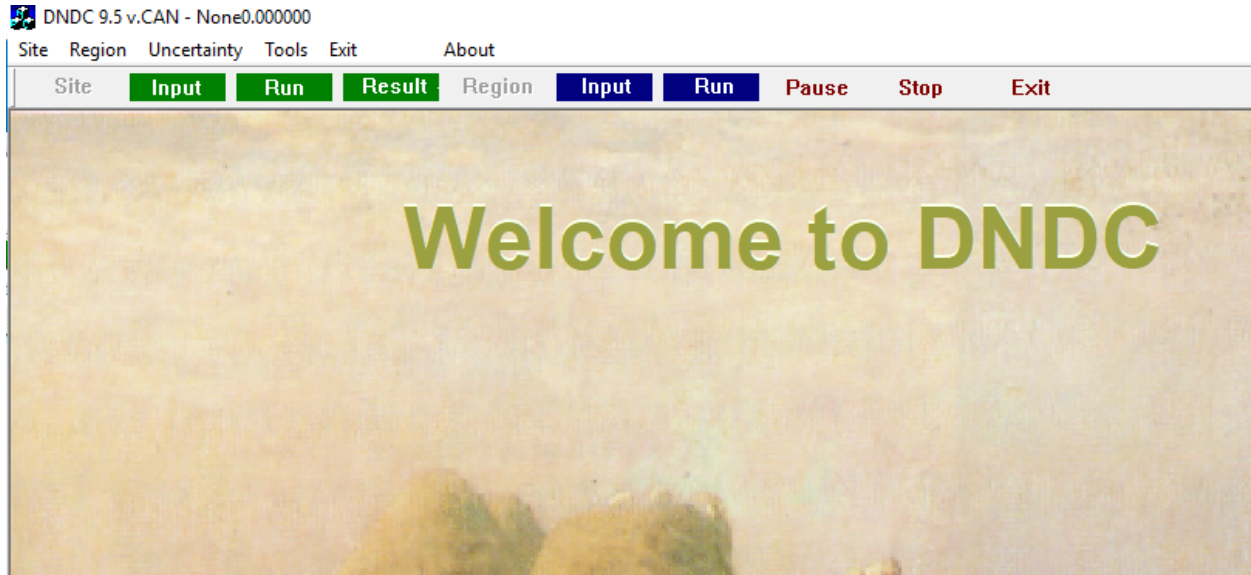


## **Section 1: DNDCv.CAN: Basics**



The DNDC model is a simple model to get running compared with some of the other popular ecosystem models available. This version which is modified from the base U.S. release is built off the 2015 DNDCv95 codebase. The primary user guide can still be useful for understanding this version of the model (<http://www.dnrc.sr.unh.edu/model/GuideDNDC95.pdf>) and should be referred to if you aren't familiar with DNDC. All model inputs are saved to a single file with the file type defined as a ".dnd" file. This file can be edited with a text editor once one becomes familiar with the format structure. The model, however, expects a very specific line by line formatting of the inputs. The major differences in this version of the model are listed below.

### **Current Development (as of August 2020):**

1. Model Extension to 200 cm from 50 cm
2. File Outputs aggregated into a single file instead of yearly
3. Heterogeneous Profile Description
4. Root Density, Depth Functions
5. Manure Slurry additional characterization (pH, N content, dry matter content etc)
6. Dynamic Water Table or Free Drainage Simulation
7. Tile Drainage, Controlled Drainage, and Sub-Irrigation capabilities
8. Improved Soil Temperature, Evapotranspiration
9. Germination timing for Corn/Soybean
10. Additional Parameterization Controls on Trace Gas Emissions, Evaporation, N movement, Urea Hydrolysis, crop interception

11. Read CO<sub>2</sub> from File location, AutoHarvest Capabilities, AutoFertilization with Farm Agent Manager (soil testing N methodology), Read from Spinup file to shorten batch simulation timing.

### **Future Developments: In the works**

1. Additional Controls on Vegetative and Reproductive Water Stress Timing
2. Dynamic Leaf, Stem, Root, Fractions with C:N
3. Germination timing across additional crops
4. CO<sub>2</sub> respiration controls per major crop type (Legumes vs Cereals)
5. Grazing Controls on grass productivity
6. Radiation/Thermal GDD hybrid growth system

### **Section 2: Installing DNDC**

The DNDC model does not have a built in front-end for installing. The model should be installed to the main drive directory. This can be your C: , D: or whatever drive.

For example if installing DNDC to the C: drive the directory structure would look like

C:\DNDC

With Subdirectories

C:\DNDC\Database

C:\DNDC\Library

C:\DNDC\Result

The model outputs all simulation outputs to one of two directories

DNDC\Result\Record\Site\ for single site simulations.

Or

DNDC\Result\Record\Batch\ for multiple batch run simulations

**Important:** Output Files have for the most part combined into single files. This is quite different from base version DNDC95 which generated single year files for each output. I.e. Day\_Climate1, Day\_Cimate2, Day\_Climate3 are now all reported in Day\_Climate1

### **Section 3: Explaining the Graphic User Input Interface differences between DNDC95 and DNDCv.CAN**

## Climate:

Table 1: Climate Tab

Input Information

Climate | Soil | Cropping | TileDrain and Model Params | Save

Site: NEBS0601

Latitude: 41.2

Simulated years: 1 Record daily results: ☐

Open an input data file

Obtain meteorological data from your database

Select Climate Files Down Up Use 1 year climate file for all years: ☐

D:\DNDC\soybeanET\Sensitivity\output\NEBS0601.txt

N concentration in rainfall (mg N/l or ppm) = 0.5

Atmospheric background NH3 concentration ( $\mu\text{g N/m}^3$ ) (0.06) = 0.06

Atmospheric background CO2 concentration (ppm) (350) = 360

Annual increase rate of atmospheric CO2 concentration (ppm/yr) = 0

Or read annual CO2 concentrations from a file: ☐

CO2 File Name:

Accept

Select a format matching your climate file(s)

- ☐ Jday, MeanT, Prec
- ☐ Jday, MaxT, MinT, Prec
- ☐ Jday, MaxT, MinT, Prec, Radiation
- ☐ Jday, MaxT, MinT, Prec, WindSpeed
- ☒ Jday, MaxT, MinT, Prec, WindSpeed, Radi, Humi
- ☐ Jday, MaxT, MinT, Prec, WindSpeed, Humidity
- ☐ Jday, MaxT, MinT, Prec, Humidity

Prec (cm), Radiation (MJ/m2/day), WindSpeed (m/s), Humidity (%)

OK Cancel Apply Help

Mostly the same as previous DNDC95 versions. The biggest difference is that a pathname can now be provided to link to the MultiYear\_CO2 file that was previously input in the DNDC\Results\inputs folder. The file now can be located in any location and the pathname will be saved to the dnd model output file.

## Soil Tab:

Table 2: Soil Tab

**Input Information**

Climate | **Soil** | Cropping | TileDrain and Model Params | Save

Land-use: (1) Upland crop field

Define soil texture profile by specifying:

top soil (0-10cm) texture: ☐ (selected)  
Heterogeneous profile: ☒

Soil structure:

Bypass flow rate (0-1): 0

WaterTable Depth (m): 2.5  
2m=WaterTable Active: >2m= NoWaterTable

Water Table (0=Yes 1=No): 1  
0=TileDrainActive, 1=FreeDrain

Initial soil organic C (SOC) content, partitioning and profile

SOC at surface soil (0-10cm) (kg C/kg soil): 0.0175

SOC profile:

Re-define: ☐

Depth of top soil with uniform SOC content (m): 0.2

SOC decrease rate below top soil (0.5 - 5.0): 2

SOC partitioning:

Re-define: ☐ Bulk C/N: 10.0908

	V.I. litter	Labile litter	Resistant litter	Humads	Humus	Biochar
Fraction	0	0	0.01	0.0219	0.9681	0
C/N	5	25	100	10	10	500

Modify decomposition rates by multiplying a factor for SOC pools:

☐ Litter: 1 Humads: 1 Humus: 1

Initial N concentration at surface soil (mg N/kg):

nitrate: 0.5 ammonium: 0.05

Microbial activity index (0-1): 1

Slope (0-90 degree): 1

Soil salinity index (0-100): 0

Rain water collection index: 1

Use SCS and MUSLE functions: ☒

Define hydro-parameters

Accept / Save Changes

OK Cancel Apply Help

The primary new feature here is controlling whether to run the model with a dynamic water table and tile drains. Should do both at the same time (dynamic water table + tile drains OR no water table)

**Water Table (0=Yes 1=No)** parameter: Water Table = 0 means Dynamic Water Table is ON (sorry a bit of reversed logic here - will fix in future). Boundary conditions at the bottom profile (200cm) are set to not drain. In this case, tile inputs need to be parameterized in the **TileDrain and Models Params** tabs.

**Water Table = 1** means boundary conditions are set to free drainage at the bottom 200cm layer. Water Table is off. By default here there is no tile information read by the model if the water table is off.

Note: the **Water Table Depth (m)** will change and indicate what the water table boundary conditions are when you change the Water Table (0=Yes 1=No) parameter.

**Define soil texture profile by selecting the radio button either for**

**Top soil (0-10cm) texture** = homogeneous soil profile (default)

**Heterogeneous Profile** = will launch Table 3 : Heterogeneous Soil Profile

**Table 3: Heterogeneous Soil Profile**

Input Information

Define heterogeneous soil profile

Thickness of soil profile (m)

2

Number of texture layers

9

	Thickness (m)	Density (g/cm <sup>3</sup> )	SOC (kgC/kg)	pH	Texture	Clay (fraction)	Fldcap (wfps)	Wiltpt (wfps)	Porosity (v/v)	Hydro-Cond. (m/hr)
Layer 1:	0.05	1.41	0.017	5.7	[4] Silt Loam	0.12	0.841	0.491	0.469	0.001
Layer 2:	0.1	1.41	0.017	5.7	[4] Silt Loam	0.12	0.841	0.491	0.469	0.001
Layer 3:	0.2	1.33	0.016	5.7	[4] Silt Loam	0.12	0.797	0.479	0.498	0.001
Layer 4:	0.1	1.36	0.014	5.7	[4] Silt Loam	0.12	0.806	0.501	0.486	0.001
Layer 5:	0.1	1.36	0.014	5.7	[4] Silt Loam	0.12	0.806	0.501	0.486	0.001
Layer 6:	0.3	1.36	0.011	5.7	[4] Silt Loam	0.12	0.806	0.501	0.486	0.001
Layer 7:	0.3	1.31	0.006	5.7	[4] Silt Loam	0.12	0.772	0.436	0.505	0.001
Layer 8:	0.35	1.31	0.003	5.7	[4] Silt Loam	0.12	0.772	0.436	0.505	0.001
Layer 9:	0.5	1.31	0.001	5.7	[4] Silt Loam	0.12	0.772	0.436	0.505	0.001
Layer 10:	0	0	0	0		0	0	0	0	0

Read profile data from a file

OK / Save

Cancel

OK

Cancel

Apply

Help

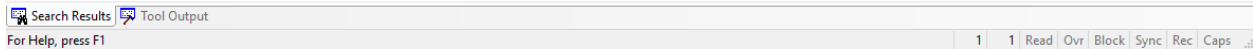
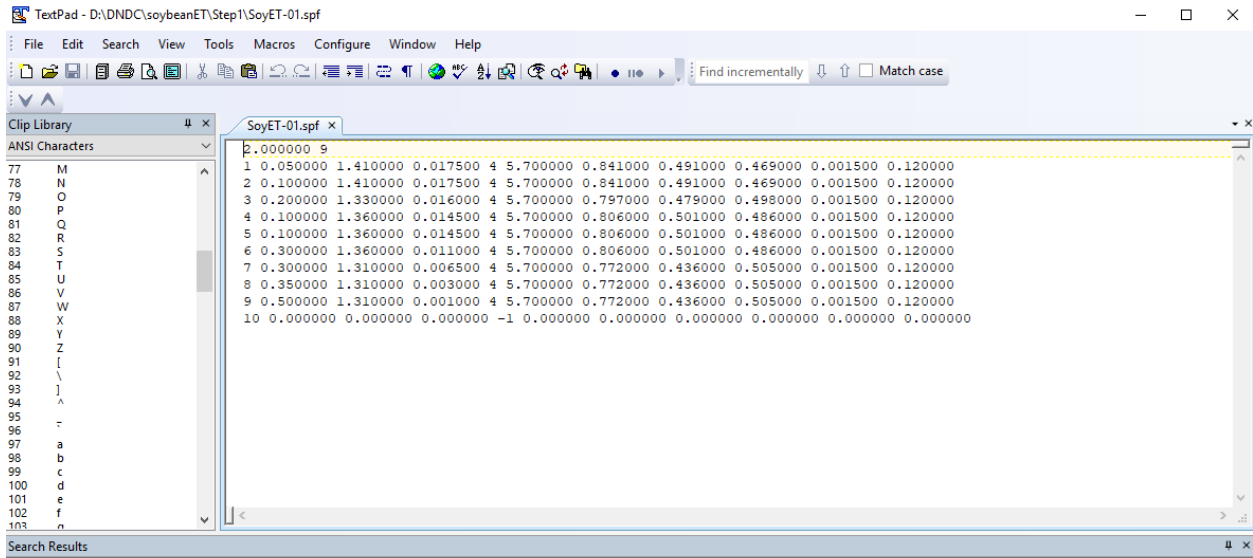
Define the soil layers here.

The thickness of Soil profile should always be set to 2m regardless if your soil profile measurements characterize the full depth. Just extend the deepest measured layer to the bottom of the profile or estimate the deeper profiles.

**Note:** You will be required to save your soil profile file even if you don't make any changes. (will fix in a later date).

**Important!:** Currently, the SOC pool fractions will be set to default after the heterogeneous soil tab is edited. Please reset to your intended values (also slated to be fixed).

**Table 5: Sample heterogeneous soil.spf file after saving from DNDC graphic user interface**



## TileDrain and Model Parm's Tab:

Table 6: TileDrain and Model Parm's Tab

Input Information

Climate Soil Cropping TileDrain and Model Parm's Save

Tile Drain Configuration

Drain Depth (m)	1	(0-2)
Drain Spacing (m)	10	(0-100)
Drain Radius (m)	0.07	(0-5)
Depth to Bedrock (m)	3	(0-10)
keDrain Factor	0.6	(0-20)

NO3 movement - TileDrained

MaxNF Overall N movement (def=0.5)	0.5	(0-1)
Avail NO3 to next layer	0.9	(0-1)
N not pref leached when Sat	0.75	(0-1)

NO3 movement - No Tile

Fraction of N that DOES NOT move preferentially through layers (def 0.9)	0.96	(0-1)
Overall N leaching Factor	1	(0-2)
Soil N retention Factor 1=No Restriction	0.3	(0-1)

Soil Parameters

Urea Hydrolysis Rate	1	(0-2)
Urea Hydrolysis WaterF	1	(0-1)
Multiplier Soil Evap	0.7	(0-2)
SnowRunOff Factor	0.2	(0-2)
Runoff N Factor	1	(0-2)
Snow Insul. Temp Factor	1	(0-2)
SnowMelt Factor	1	(0-2)
Solar eff. on Soil Temp.	1	(0-2)

Additional Factors

AutoHarvest On	1	(1:Yes 0:No)
Soil Struc Effect	0	(1:Yes 0:No)
Reset Soil (annual) after 10 years	0	(1:Yes 0:No)
Read from spinupFile	<input checked="" type="checkbox"/>	Every # Yrs 1
D:\DNDC\soybeanET\sensitivity\base\spinup		

Trace Gas Parameters

Denitrifier Growth Rate	1	(0-2)
Nitrifier Growth Rate	1	(0-2)
Nitrification Factor	1	(0-2)
Rain Intensity Factor	1	(0-2)
Spring Melt Multiplier	1	(0-2)
NH3 Vol Wind Fact	1	(0-1)

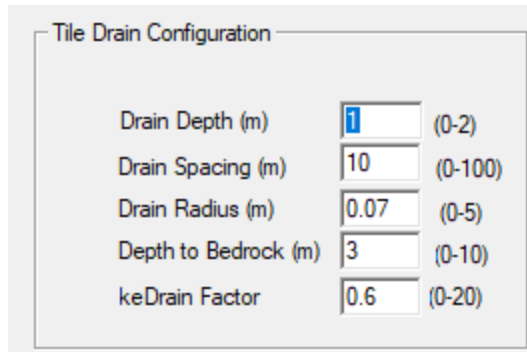
Soil Water Factors

SWC impact from WT	1	(0-1) - Default=1
RainFall Intercept Factor	0	(0-10)

ACCEPT

OK Cancel Apply Help

This tab is meant to define the general tile drain setup for the simulation (if the water table is simulated - otherwise ignore) and allows for greater control over internal parameters that affect major outputs (Trace gas, N movement/leaching, soil temperature, water balance, etc)



Tile Drain Configuration		
Drain Depth (m)	1	(0-2)
Drain Spacing (m)	10	(0-100)
Drain Radius (m)	0.07	(0-5)
Depth to Bedrock (m)	3	(0-10)
keDrain Factor	0.6	(0-20)

The tile flow rate is based on the houghoudt equation.

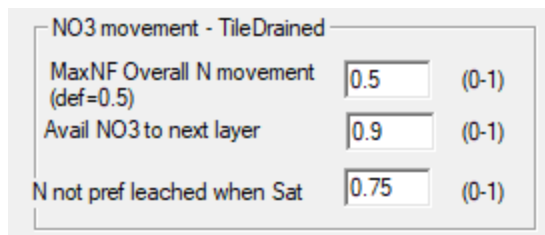
**Drain Depth (m)** = Tile drain location in the 2 m profile. Should be placed within the profile so typically it is between 50cm and 150 cm.

**Drain Spacing (m)** = This is a mainly a 1-d model but the drain spacing is empirically used to simulate quasi-2d flow rate to tiles. Wider drain spacing will result in lower flow to tiles.

**Drain Radius (m)** = This also controls the flow rate of water to tiles. Larger radius results in higher flow rates.

**Depth to Bedrock (m)** = by default set to 3m. Flow rate to drains is directly proportional to effective depth.

**keDrain Factor** = rate of horizontal effective saturated conductivity to the tiles. It is a function of the saturated conductivity defined in the soil profile but this factor can be used to slow or increase the horizontal flow rate.



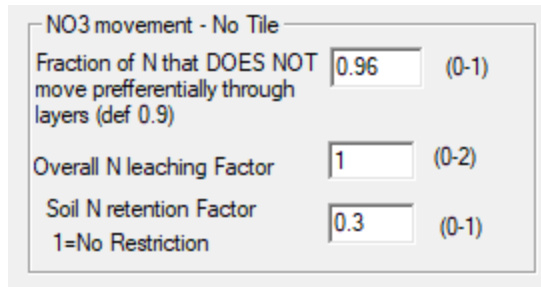
NO3 movement - TileDrained		
MaxNF Overall N movement (def=0.5)	0.5	(0-1)
Avail NO3 to next layer	0.9	(0-1)
N not pref leached when Sat	0.75	(0-1)

These parameters again are only involved if tile drains are present.

**MaxNF** = Primary control that influences the maximum nitrogen movement across the soil layers. It is a factor that controls that maximum threshold value.

**Avail NO3 to next layer** = At a timestep of 1 hour, this determines the amount of NO3 available to be mobilized with water flux to move to the next layer.

**N not pref leached when Sat** = The fraction of N that is not susceptible to preferential leaching (i.e. bypass all layers to move directly to the tiles) when the water table is above the tiles.



NO3 movement - No Tile		
Fraction of N that DOES NOT move prefferentially through layers (def 0.9)	0.96	(0-1)
Overall N leaching Factor	1	(0-2)
Soil N retention Factor 1=No Restriction	0.3	(0-1)

These parameters are used to control N movement when tiles are not present in the simulation.

**Fraction of N that does not move preferentially** = self-explanatory but it is defined as the N that does not bypass the layer to layer movement on N to preferentially leach out of the soil profile.

**Overall N leaching Factor** = A factor that controls the fraction of NO3 (and a small amount of Urea) in a layer that moves with water fluxes between layers.

**Soil N retention Factor** = A control used to restrict N movement on a per-layer basis. This is an exponential algorithm that makes N more and more difficult to be moved as the absolute amount of N in a layer decreases.

**Urea Diffusion Factor** = A control used to control how fast urea can diffuse into the soil matrix. The default is 0.08 and increasing the value upwards will increase the rate of urea diffusion.



Soil Parameters		
Urea Hydrolysis Rate	<input type="text" value="1"/>	(0-2)
Urea Hydrolysis WaterF	<input type="text" value="1"/>	(0-1)
Multiplier Soil Evap	<input type="text" value="0.7"/>	(0-2)
SnowRunOff Factor	<input type="text" value="0.2"/>	(0-2)
Runoff N Factor	<input type="text" value="1"/>	(0-2)
Snow Insul. Temp Factor	<input type="text" value="1"/>	(0-2)
SnowMelt Factor	<input type="text" value="1"/>	(0-2)
Solar eff. on Soil Temp.	<input type="text" value="1"/>	(0-2)

**Urea Hydrolysis Rate** = Controls the overall hydrolysis rate (temp, water, [substrate])

**Urea Hydrolysis WaterF** = Controls the effect of water content on hydrolysis

**Multiplier Soil Evap** = Controls the effective soil evaporative rate. >1 = increased soil evap.

**SnowRunoff Factor** = Fraction of excess snowmelt that can't infiltrate the soil that leads directly to runoff

**Runoff N Factor** = Factor that controls the amount of N that moves with runoff from the top 2 soil layers.

**Snow Insul Temp Factor** = Factor that controls the influence of snow on surface soil temperatures.

**SnowMelt Factor** = Controls the Rate of Snowmelt as a function of air temperature.

**Solar Effect on Soil Temp** = Controls the effect of solar radiation on surface soil temperature. A higher value will increase overall soil temperatures in the peak of summer growing season.

Trace Gas Parameters		
Denitrifier Growth Rate	<input type="text" value="1"/>	(0-2)
Nitrifier Growth Rate	<input type="text" value="1"/>	(0-2)
Nitrification Factor	<input type="text" value="1"/>	(0-2)
Rain Intensity Factor	<input type="text" value="1"/>	(0-2)
Spring Melt Multiplier	<input type="text" value="1"/>	(0-2)
NH3 Vol Wind Fact	<input type="text" value="1"/>	(0-10)
NH3 Soil Depth Fact	<input type="text" value="1"/>	(0-10)
N2:N2O factor	<input type="text" value="2"/>	(0.0001-1000)

**Trace Gas Parameter controls**

**Denitrifier Growth Rate** = Controls the growth rate of microbial denitrifiers in the anaerobic balloon

**Nitrifier Growth Rate** = Controls the growth rate of microbial nitrifiers in the anaerobic balloon

**Nitrification Factor** = Controls maximum nitrification kg/ha amount per hour

**Rain Intensity Factor** = Controls the influence of rain on the denitrification rate. This is an empirical factor that increases N<sub>2</sub>O, NO and N<sub>2</sub> emission peaks in response to rainfalls

**Spring Melt Multiplier** = Controls the influence of freezing events on substrate availability to promote denitrifier activity in the spring melt period.

**NH<sub>3</sub> Vol Wind Factor** = Controls the influence of windspeed on the volatilization rate of ammonia produced during the NH<sub>3</sub>:NH<sub>4</sub> equilibrium and Henry's law.

**NH<sub>3</sub> Soil Depth Factor** = Controls the influence of soil depth on reducing NH<sub>3</sub> emissions. This represents in a crude way the diffusivity ease of NH<sub>3</sub> from depth along with the binding of NH<sub>3</sub> to soil colloids within the soil matrix. Default = 1.0. Decreasing this value will make the impact of depth greater.

**N<sub>2</sub>:N<sub>2</sub>O Factor**: Larger values increases the amount of N<sub>2</sub> formed from N<sub>2</sub>O

Soil Water Factors

SWC impact from WT  (0-1) - Default=1

RainFall Intercept Factor  (0-10)

**SWC impact from WT** = this is tied to the influence of the water table on water contents above the water table and the extractability of this water for transpiration. A lower value will force more water update from the water table (and increase soil water contents).

**Rainfall Intercept Factor** = This allows the user to control the amount of intercepted rainfall that is lost to the canopy and evaporated.

Additional Factors

AutoHarvest On	<input type="text" value="0"/>	(1:Yes 0:No)
Soil Struc Effect	<input type="text" value="1"/>	(1:Yes 0:No)
Reset Soil (annual) after 10 years	<input type="text" value="0"/>	(1:Yes 0:No)
Read from spinupFile	<input type="checkbox"/> Every # Yrs	<input type="text" value="0"/>

**AutoHarvest On** = let the model autoharvest crops when GDD/TDD reaches maturity and after a brief drying out of the crop

**Soil Struc Effect** = Let soil characteristics (i.e. water holding capacity) change be correlated with soil organic matter changes (i.e. as a proxy of soil health)

**Reset Soil (annual) after 10 years:** After a 10 year sequence (normally tied to a spinup period) let the soil conditions be reset every year afterwards so that every subsequent year is using the end of the 10th year as its initial conditions (i.e. year 11, year 12 +++)

**Read from spinup File** = click to read from file and the frequency to read from that file (every 1 year, 2 years etc). This file is in the format that is automatically written out in the DNDC\Result\inter\ directory and labelled soil\_1, soil\_2 etc

## Farming Management Practices Tab

**Crop:**

**Table 7: Crop Tab.**

Farming Management Practices

Crop | Tillage | Fertilization | Manure Amendment | Irrigation | Flooding | Film mulch | Grazing or cutting

Number of new crops planted in this year =

Crop # =  < >

Crop type:

This is a perennial crop ☒

Is it a cover crop? ☐ Yes ☒ No

Planting month:  day =

Harvest month:  day =

Transplanting ☐ Yes ☒ No

Harvest mode 1: in this year; 2: in next year

Fraction of leaves+stems left in field after harvest (0-1)

Alfalfa WinterKill Parameters

Alfalfa hardening rate cHRMX (0.184)	<input type="text" value="0.184"/>
Alfalfa dehardening rate cDRMX (0.82)	<input type="text" value="0.82"/>
Alfalfa maximumT cultivar cTMX oC (-15.0)	<input type="text" value="-15"/>
Alfalfa plant death pop rate pDFMX (0.108)	<input type="text" value="0.108"/>

Crop parameters

	Grain	Leaf	Stem	Root
Max. biomass production, kg C/ha/yr	<input type="text" value="56.14"/>	<input type="text" value="1656.1"/>	<input type="text" value="1656.1"/>	<input type="text" value="2245.6"/>
Biomass fraction	<input type="text" value="0.01"/>	<input type="text" value="0.295"/>	<input type="text" value="0.295"/>	<input type="text" value="0.4"/>
Biomass C/N ratio	<input type="text" value="10"/>	<input type="text" value="10"/>	<input type="text" value="10"/>	<input type="text" value="35"/>
Annual N demand, kg N/ha/yr	<input type="text" value="401"/>			
Thermal degree days for maturity	<input type="text" value="1500"/>			
Water demand, g water/g DM	<input type="text" value="100"/>			
N fixation index (crop N/N from soil)	<input type="text" value="1"/>			
Optimum temperature (degree C)	<input type="text" value="21"/>			
Maximum Root Length (m)	<input type="text" value="2"/>			
Root Density Shape Func	<input type="text" value="5"/>			
PGI Grain Filling Stage	<input type="text" value="0.5"/>			
LAI maximum	<input type="text" value="4"/>			
FrostKill Temp	<input type="text" value="-2"/>			
Tree maturity age (years)	<input type="text" value="0"/>			
Tree current age (years)	<input type="text" value="0"/>			
Tree leaf biomass, kg C/ha	Max <input type="text" value="0"/>	Min <input type="text" value="0"/>		

Accept

CropID	CropType	Planting	Harvest	Mode	Residue	Yield
1st crop	10	5	15	1	0.500000	56.139999

OK Cancel Apply Help

Some new parameters have been added to the crop parameters tab for DNDCv.CAN

**Nfixation index** = this has changed from default DNDC. 0= no crop N fixation, 1 = full crop N fixation capability

**Maximum Root Length** = Root length for crop into the soil profile

**Root Density Shape Func** = The shape of the density distribution from the surface to maximum root length. 1= more emphasis on surface roots, 8 = more even distribution of root density

**PGI Grain Filling Stage** = Plant Growth Stage (0-1) at which grain filling occurs

**LAI maximum (important)** - This should be set to the maximum LAI value for a particular crop type. This has relevance for calculation potential evapotranspiration rates

**FrostKill Temp (not used atm)**

#### **Alfalfa Winterkill Parameters**

**CHRMX** = hardening rate of alfalfa (oC d-1) - default 0.184

**CDRMX** = dehardening rate of alfalfa (oC d-1) default 0.82

**cTMX** = maximum cold tolerance of alfalfa cultivar (oC) default -15.0

**pDFMX** = plant population death rate (oC d-1 below cTMX) default 0.108

See (Kanneganti, V. Rao, C. Alan Rotz, and Richard P. Walgenbach. "Modeling freezing injury in alfalfa to calculate forage yield: I. Model development and sensitivity analysis." *Agronomy Journal* 90, no. 5 (1998): 687-697)

#### **Manure Amendment**

##### **Table 9: Manure Parameters**

Farming Management Practices
X

Crop
Tillage
Fertilization
Manure Amendment
Irrigation
Flooding
Film mulch
Grazing or cutting

External manure amendment

Applications in this year
0

Application #
0
< Last
Next >

Month = 0
Day = 0

Manure type

Solid C/N ratio
0
Urea and NH4+ (kg N/ha)
0

Organic C (kg C/ha)
0
NO3- (kg N/ha)
0
Manure Dry Matter %
0

Organic N (kg N/ha)
0
Manure pH
0
Manure Application Hour
0

Application method
☒ Surface spread
☐ Incorporation (over depth)
☐ Injection (at depth)
Depth (cm)
0

Accept

Application	Month	Day	Type	Manure-C	C/N	ManureOrg-N	Man

## Irrigation Parameters

### Controlled Drainage:

Allows the user to schedule drainage which is managed to keep the water table at a certain depth.

Crop

Tillage

Fertilization

Manure Amendment

Irrigation

Flooding

Film mulch

Grazing or cutting

Irrigation input mode

☒ Based on irrigation events
 Number of irrigation events =

☐ Based on an irrigation index
 Irrigation index (0-1) =

Input Irrigation date and amount for each irrigation event

Irrigation #  < >
 Month =  Day =

Amount of water applied (cm) =

Method

☒ Furrow
 ☐ Sprinkler
 ☐ Drip (0cm)
 ☐ Drip (15cm)

SubSurface Irrigation

☐ Tile Irrigation
 Tile Irrigation Days

Irr.ID	Month	Day	Water-cm	Method	TimeDays

Controlled Drainage

Number of applications

Application #

< >

From

Month =  Day =

To

Month =  Day =

Controlled Drainage Depth (m)

ID	StMonth	StDay	EndMonth	EndDay	CDepth
1st cDrain	0	0	0	0	0.000000

## Grazing Management

Farming Management Practices

Crop | Tillage | Fertilization | Manure Amendment | Irrigation | Flooding | Film mulch | **Grazing or cutting**

Grazing

Number of grazing applications =

Grazing # =  <- Last Next ->

Start month =  day =

End month =  day =

Grazing hours per day =

Grazing intensity (heads/ha):

Dairy cow	Beef/veal	Sheep	Horse	Pig
<input type="text" value="0"/>	<input type="text" value="15.2"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>

Additional feed (kg C/head/day)  Feed C/N

Excreta handle

Grazing Impact on Biomass Regrowth

Fraction of Live Biomass C consumed

Fraction of consumed C excreted

Biomass cutting

Number of cuts =

Cutting # =  <- Last Next ->

Month =  day =

Cut part ☐ Grain ☐ Leaf ☐ Stem ☐ Root

Cut fraction (0-1)

Accept

Graz.ID	Start M	Start Day	End M	End Day	Dairy	Beef	Pig	Sheep	Horse
1st graz	6	1	6	30	0.00	15.20	0.00	0.00	0.00
2nd graz	8	1	8	30	0.00	15.20	0.00	0.00	0.00

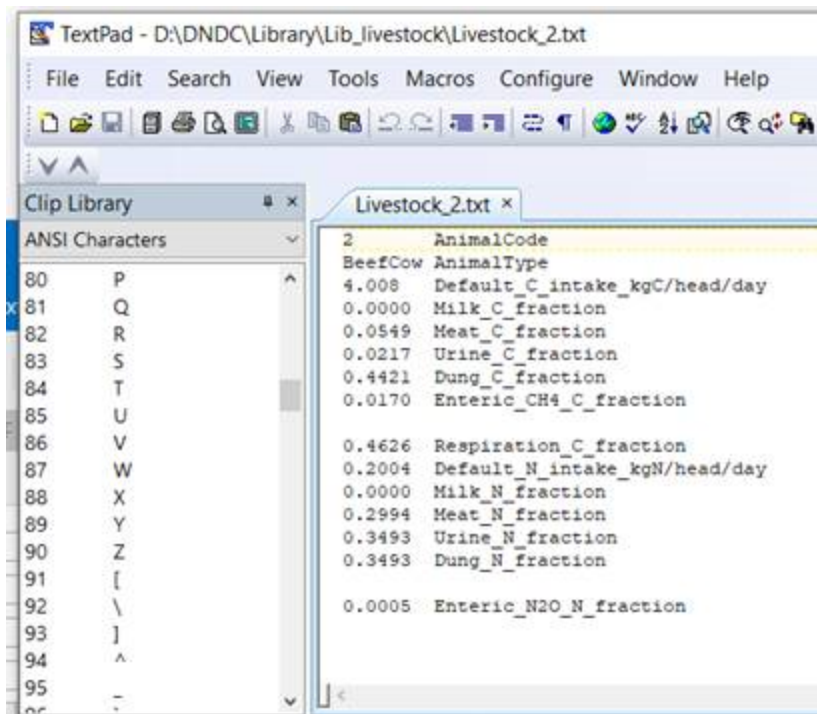
Cut.ID	Month	Day	Fraction

OK Cancel Apply Help

**Grazing Impact on Biomass Regrowth:** New parameter that allows one to put a stress factor during grazing events on growth. 1= no stress and 0.1 would be very high stress. It only affects perennial growth if the crop is not already at maturity. Grazing should in essence reset PGI but it currently does not and only reduces the aboveground biomass absolute amount.

The Livestock.txt files included in the DNDC\library\lib\_livestock\ directory have animal consumption and C&N flow controls that can be adjusted to influence the way live biomass C is consumed and deposited back to the field. Please note that the summation of input and output fractions should add up to 1.0





## **Section 4: Building A New DNDC File using the Graphics User Interface.**

### **Background:**

DNDC can be a bit problematic when trying to build complex time blocks. The logic used in the internal code can get confused when the process of building time blocks is not followed in a linear manner (i.e. done from the beginning to the end). To prevent the painful exercise of building complex management data only to have the model corrupt the sequence of the data after you try to save it, try to follow these steps. Try not to add new time blocks after you've done the following steps unless you do so with a text editor directly to the file.

### **Steps**

1. Fill in the appropriate data for the **climate tab** and click **Accept**.
2. Fill in the appropriate data for the **soils tab** and click **Accept/save changes**.
3. Click on the **Crops Tab**.
4. Build the structure for your all of your time blocks without filling in any data. (i.e. 3 time blocks , block 1 – number of years this crop rotation occurs, number of unique crop years within this rotation.
5. Ensure you've built the structure for the number of time blocks so that it populates the full duration of your simulation years.
6. Now click **Define management practices for this year** and enter into the crop page.

7. On the crop page just click Accept (don't fill in any data) and then click OK.
8. Go onto the next unique year/time block and repeat steps 6-7 for each unique year/block.
9. Finally go to **TileDrain and Model Parm**s tab and click **Accept**
10. Now go to Save and Save your file.
11. Now try to open your newly created dnd file and ensure your time block structure is correct.
12. If everything appears correct you can now proceed to enter in your specific management data for your time blocks in the **Define management practices for this year**
13. **Save your work.**

## Explaining the auto-fertilizer farm agent routine

Farming Management Practices X

Crop | Tillage | Fertilization | Manure Amendment | Irrigation | Flooding | Film mulch | Grazing or cutting

☐ Manual

Applications in this year =  Application #  < > Metric ☒ English ☐

Application date Month  Day

Application depth ☒ surface ☐ injection Depth (cm)

Applied amount of fertilizers: kg N or P or S/ha lb N/acre

Urea  Anhydrous ammonia  Ammonium bicarbonate  Nitrate

Ammonium  Sulphate  Phosphate

☒ Auto-fertilization

Urea is automatically applied on planting day at rate determined by crop demand and soil available N

☐ Precision fertilization

Urea is automatically applied at daily time step if N stress is detected

☐ Fertigation

Select Fertigation File

Additional alternative method

Controlled release fertilizer ☐ Days for total N release

Using nitrification inhibitor ☐ Efficiency (0-1)  Effective duration (days)

Using urease inhibitor ☐ Efficiency  Effective duration (days)

Accept

Fer-ID	Month	Day	Method	Nitrate	NH4HCO3	Urea	NH3	NH4NO3	Sulphate	(NH4)2H...	Depth
1st N-App	5	27	0	0.000	0.000	100.000	0.000	0.000	0.000	0.000	0.20

< >

OK Cancel Apply Help

DNDCv.CAN has a built-in smart farmer algorithm that tries to emulate the concept of what a farmer with access to soil N testing would do to fertilize their field for the upcoming season. The routine works by assessing at time of fertilizer (planting or split application) what the current soil N levels (ammonium/nitrate + residue N) are and the optimal crop N requirements (for that specific cultivar) would be to estimate the incoming N requirements for that season. An estimate of the anticipated N losses (including volatilized N, leaching N, N<sub>2</sub>O etc) are also factored in along with typical available N input from N mineralization. This is all wrapped into a crop-specific N stress factor that is used to come up with a scalar that is multiplied against the anticipated N fertilizer application (based on soil N testing etc). This crop-specific N stress factor is based on up to the last 10 occurrences of that crop type in the rotation over the past. It is conceived that the farmer would be noting how his crop (i.e. corn, barley etc) has been performing over the last 10 occurrences in the rotation and would be hedging his bets based on this gained insight to modify his fertilizer rate. The strength of this routine is that it can be used to carry forward climate change investigations that would have cascading impacts on crop yields and N availability without having to hard set fertilizer rates. If crop yields improve slowly under climate change due to CO<sub>2</sub>/water stress then the farmer would slowly increase his anticipated fertilizer rate to accommodate these improved growing conditions. Alternatively if yields decrease due to increased temperature stress then the farmer would decrease N applied to ensure N application matched crop N needs.

Capabilities of algorithm - Up to 10 unique crop types can be considered when using this algorithm. If your rotation includes more than 10 unique crop types you should avoid using autofertilizer.

Up to 2 applications can be utilized for autofertilization for a given year, thus allowing for split application.

The timing of the autofertilizer application should be entered along with the relative formulation (fertilizer type) to be used (i.e. ammonium, UAN, urea). The absolute values for each of these is determined by the routine but the relative contribution is important to enter. Also in respect to split application the relative magnitude between applications is considered by the routine so if one wants a small starter and a larger split these should be entered into the 2 applications accordingly (actually this is hardset atm to 18 kg N for first application and the 2nd application is based on soil N requirements).

## **Section 5: Known DNDCv.Can issues**

The DNDC model is in a constant development cycle. There are however many known quirks that are being addressed.

1. Monte Carlo uncertainty is not fully operational at this time. Some of the newer outputs have not been properly added to this feature and require development.
2. Output Files may not be fully defined for units in the header files.
3. Regional DNDC does not work. We see no advantage of running in this mode over the batch simulation mode already built into DNDC

## **Command Line Version of DNDC - New Nov 2021**

A new command line (terminal version of DNDC is available and packaged with the DNDC release). It disables the Graphic User Interface and allows users to run batch simulations using a command line interface. This should allow the model to be run via scripting languages (R-Software, Perl etc) and allow for bayesian calibration methods to be employed to model simulations.

The operation of the command line version can be done with the separate included executable and run using the following command line.

From the command prompt: `start /wait dndc95.exe -s [Batch File path]`

Example: `start /wait dndc95.exe -s D:\batch.txt`

To enable/disable this compile in the source code modify `dndc_main.h` and `Source_main.h` to have enabled `#define Console` or disabled.