ENVIRONMENTAL POLICY INTEGRATED CLIMATE MODEL

VERSION 1102

TEXAS A&M – AGRILIFE RESEARCH – BLACKLAND RESEARCH CENTER

720 East Blackland Road, Temple, Texas, 76502

ENVIRONMENTAL POLICY INTEGRATED CLIMATE MODEL

USER'S MANUAL

VERSION 1102

L. DORO[3], A. MEINARDUS[1], J. JEONG[1], J.M. OSORIO LEYTON[1], E.M. STEGLICH[2]

[1] AgriLife Research – Blackland Research and Extension Center, 720 East Blackland Road, Temple, Texas, 76502

[2] USDA – Natural Resources Conservation Service, 808 East Blackland Road, Temple, Texas, 76502

[3] Digital Landscape Solutions LLC, 109 East 17th Street Suite 510, Cheyenne, Wyoming, 82001

Last updated: January 2024

To request information contact:

Luca Doro
Agroecosystem Modeler
LucaDoro@digiland-solutions.com

Jaehak Jeong
Associate Professor
Jaehak.Jeong@ag.tamu.edu

Javier M. Osorio Leyton
Assistant Professor
Javier.Osorio@ag.tamu.edu

Evelyn Steglich
Natural Resources Specialist
Evelyn.Steglich@usda.gov

To report typos or errors contact:

Avery Meinardus
Programmer I
ameinardus@brc.tamus.edu

Luca Doro
Agroecosystem Modeler
LucaDoro@digiland-solutions.com

We would like to express our sincere appreciation to Dr. Jimmy R. Williams, the father and leading developer of the EPIC model, for his many years of collaborative efforts in developing and enhancing the EPIC model.

1980s Early development.

2000 Continuous model improvement.

2020 Providing support while farming.

Image on front page by L. Doro (picture of field by Walter Frehner from Pixabay)

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MODEL OVERVIEW

The Environmental Policy Integrated Climate (EPIC) model, formerly known as Erosion/Productivity Impact Calculator, is a process-based computer model that simulates the physicochemical processes that occur in soil and water under agricultural management. It is designed to simulate a field, farm or small watershed that is homogenous with respect to climate, soil, land use, and topography – termed a hydrologic land use unit (HLU). The model was originally developed to evaluate the effect of various land management strategies on soil erosion while later developments extended EPIC's scope to encompass aspects of agricultural sustainability, including erosion (wind, sheet, and channel), water supply and quality, soil quality, plant competition, weather, pests, and economics. Management capabilities include irrigation, drainage, furrow diking, buffer strips, terraces, waterways, fertilization, manure management, lagoons, reservoirs, crop rotation and selection, pesticide application, grazing, and tillage. Besides these farm management functions, EPIC can be used in evaluating the effects of global climate/CO_2 changes; designing environmentally safe, economic landfill sites; designing biomass production systems for energy; and other spin off applications.

In the early 1980's, EPIC was developed to assess the effect of erosion on productivity (J. R. Williams, Jones, & Dyke, 1984). Various components from CREAMS (Knisel, 1980) and SWRRB (J. R. Williams, Nicks, & Arnold, 1985) were used in developing EPIC, and the GLEAMS (Leonard, 1987) pesticide model used to estimate pesticide fate - runoff, leaching, sediment transport, and decay - was added later(Sabbagh, Geleta, Elliott, Williams, & Griggs, 1991). EPIC was used to respond to the soil conservation questions raised by the 1985 National Resource Conservation Act (Putnam, Williams, & Sawyer, 1988). Since then, the model has been expanded and refined to allow simulation of many processes important in agricultural management (Sharpley & Williams, 1990) (J.R. Williams, 1995).

The computational unit or HLU (homogeneous land use unit), is an area homogeneous for soil, aspect and slope, weather, and management practice. The size of the HLU depends on the desired resolution and precision. The drainage area or HLU considered by EPIC is generally a field-size area, up to about 100 ha, where weather, soils, and management systems are assumed to be homogeneous. The major components in EPIC are weather simulation, hydrology, erosion-sedimentation, nutrient cycling, pesticide fate, crop growth, soil temperature, tillage, economics, and plant environment control. Although EPIC operates on a daily time step, the optional Green & Ampt (Green & Ampt, 1911) infiltration equation simulates rainfall excess rates at shorter time intervals (0.1 h). The model is capable of simulating thousands of years if necessary.

INPUT FILES

Master file (EPICFILE.DAT)

File format: 10 spaces, 80 alpha characters for each line. The internal EPIC file reference is included in the first 10 spaces.

The EPICFILE.DAT is used to specify the file names associated with internal EPIC file references. Usually, there is no need to edit the EPICFILE.DAT file and it is used with its default names. THE EPICFILE.DAT should be modified only by experienced model users with a full understanding of how the model operates and uses the information contained in the EPICFILE.DAT.

While it is possible to edit the content of the EPICFILE.DAT file, it is not possible to rename this file. The order of the list cannot be modified. Only one EPICFILE.DAT file can exist inside the working directory[1].

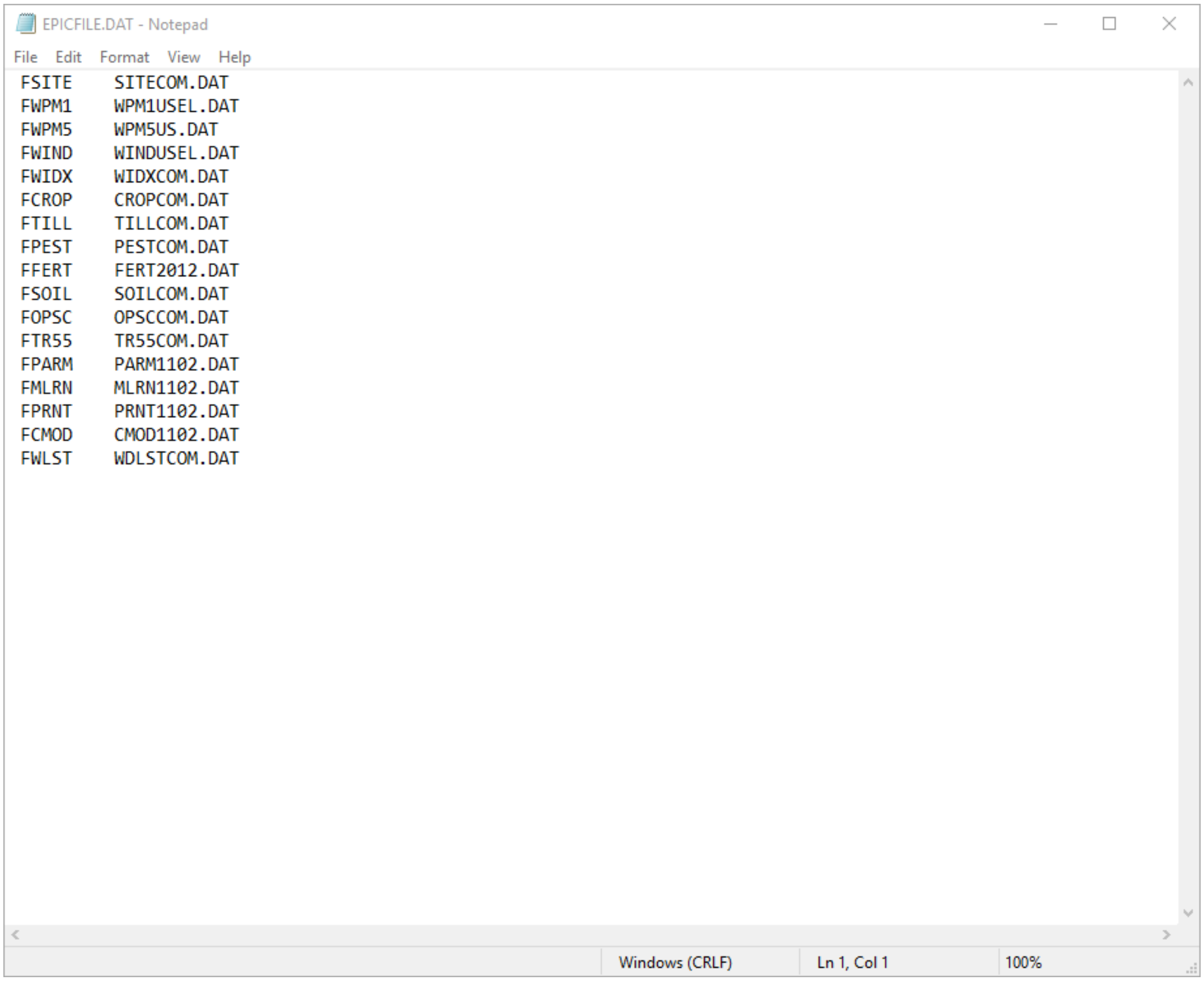
Table 1 List of file names defined in EPICFILE.DAT file.

EPIC internal file reference	Default file name	Description
FSITE	SITECOM.DAT	List of site files that can be selected to create runs. The input data for each of the site files is contained in the *filename.SIT* files.
FWPM1	WPM1USEL.DAT	List of monthly weather stations which can be used in creating runs. This file must contain the latitude, longitude, and elevation of the weather station. The input data for each of the monthly weather station files is contained in the *filename.WP1* file.
FWPM5	WPM5US.DAT	Alternate weather station catalog (used with FWIDX).
FWIND	WINDUSEL.DAT	List of wind stations which can be used in creating runs. This file must contain the latitude, longitude, and elevation of the weather station. The input data for each of the monthly weather station files is contained in the *filename.WND* file.
FWIDX	WIDXCOM.DAT	Southern oscillation coefficient file.
FCROP	CROPCOM.DAT	Crop parameter file. This file is a list of crops and the associated crop parameters needed by EPIC to simulate crop growth.
FTILL	TILLCOM.DAT	List of field operations, tillage, and equipment with the associated tillage input data.
FPEST	PESTCOM.DAT	List of pesticides and the associated input data.

[1] Working directory is defined as the directory containing the EPIC1102 executable.

EPIC internal file reference	Default file name	Description
FFERT	FERT2012.DAT	List of fertilizers and the associated input data.
FSOIL	SOILCOM.DAT	List of soil files that can be selected to create runs. The input data for each of the soil files is contained in the *filename.SOL* files.
FOPSC	OPSCCOM.DAT	List of available operation schedules which can be used to create runs. The input data for each of the operation files is contained in the *filename.OPS* files.
FTR55	TR55COM.DAT	Data for TR55 runoff estimation.
FPARM	PARM1102.DAT	Contains equation parameters and coefficients used to simulate several processes in EPIC.
FMLRN	MLRN1102.DAT	Provides for multiple runs at the same site by including an option for selecting consecutive weather seeds and water erosion without reloading the inputs.
FPRNT	PRNT1102.DAT	Controls the printing of output files and output variables in the *runname.OUT* file and other summary files.
FCMOD	CMOD1102.DAT	Database of crop prices (used only for economic analysis).
FWLST	WDLSTCOM.DAT	List of daily weather stations and their corresponding latitude, longitude, and elevation values which can be used in creating runs. The input data for each of the operation files is contained in the *filename.DLY* files.

Figure 1 Example of the EPICFILE.DAT file open in a text editor.



```
FSITE    SITECOM.DAT
FWPM1    WPM1USEL.DAT
FWPM5    WPM5US.DAT
FWIND    WINDUSEL.DAT
FWIDX    WIDXCOM.DAT
FCROP    CROPCOM.DAT
FTILL    TILLCOM.DAT
FPEST    PESTCOM.DAT
FFERT    FERT2012.DAT
FSOIL    SOILCOM.DAT
FOPSC    OPSCCOM.DAT
FTR55    TR55COM.DAT
FPARM    PARM1102.DAT
FMLRN    MLRN1102.DAT
FPRNT    PRNT1102.DAT
FCMOD    CMOD1102.DAT
FWLST    WDLSTCOM.DAT
```

EPIC run file (EPICRUN.DAT)

File format: 12 fields (8 mandatory, 4 optional), free format.

When EPIC is executed, each row in the EPICRUN.DAT file is read to determine the configuration of the runs to be made. Each line consists of an individual run. Numerous runs can be set up; however, not all must be run at the same time. To tell the model where to stop, a "XXXXXXX" line is inserted after the last run to be simulated (See Figure 2 as an example).

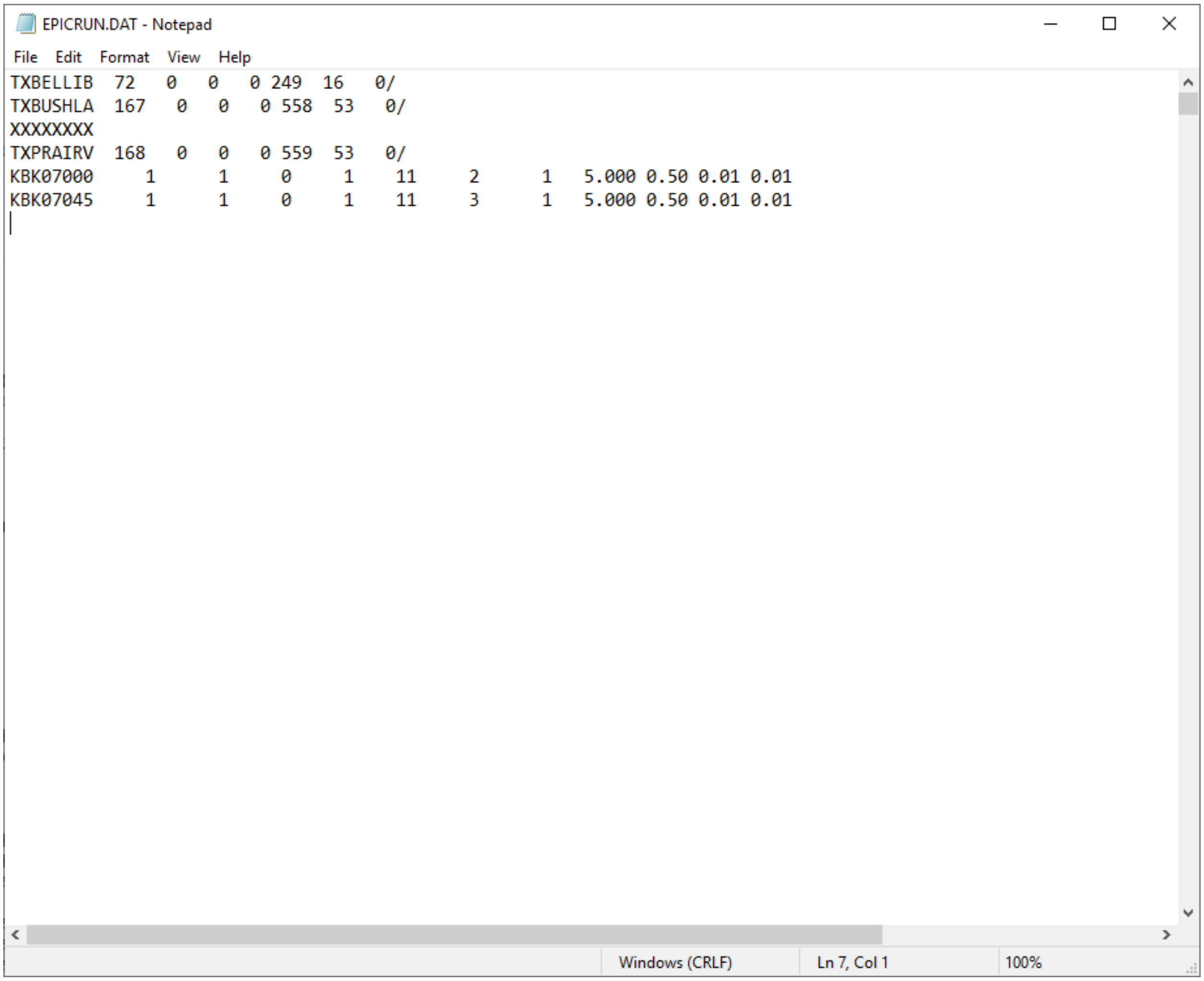
The first 8 fields are mandatory and required by the model to set up the simulation. The last 4 fields are optional. If the last 4 fields are not provided, the slash symbol (/) must be inserted at the end of each line.

Table 2 List of fields included in the EPICRUN.DAT file.

Field	Variable name	Description
1	ASTN	Run name or run number. Since ASTN will be the name used for the output files generated for each run, ASTN must be a unique ID for each run so that the output files are not written over.
2	ISIT	Site ID number. Must be one of the sites listed in the SITECOM.DAT file.
3	IWP1	Monthly weather station ID number. Must be one of the stations included in the WPM1US.DAT file. If set to zero, EPIC will use the latitude and longitude from WPM1USEL.DAT to choose the closest weather station to the simulated area (latitude and longitude from *sitefile.SIT*).
4	IWP5	Alternate catalog of monthly weather stations for use with the southern oscillation coefficients in WIDX0810.DAT. Set IWP5 to zero for not using this feature.
5	IWND	Wind station ID number. Must be one of the stations included in the WINDUSEL.DAT file. If set to zero, EPIC will use the latitude and longitude from WNDUSEL.DAT to choose the closest weather station to the simulated area (latitude and longitude from *sitefile.SIT*).
6	INPS	Soil ID number. Must be one of the soils included in the SOILCOM.DAT file.
7	IOPS	Operation schedule ID number. Must be one of the operation schedules included in OPSCCOM.DAT file.

Field	Variable name	Description
8	IWTH	Daily weather station ID number. Must be one of the stations included in the WDLSTCOM.DAT file. If set to zero, EPIC will use the latitude and longitude from WDLSTCOM.DAT to choose the closest weather station to the simulated area (latitude and longitude from *sitefile.SIT*).
9 (optional)	XKN5	Michaelis-Menten NO3- reduction constant. If a value is provided here, this will overwrite the value read from the PARM1102.DAT file (see section on PARM1102.DAT for details).
10 (optional)	XKN3	Michaelis-Menten NO2- reduction constant. If a value is provided here, this will overwrite the value read from the PARM1102.DAT file (see section on PARM1102.DAT for details).
11 (optional)	XKN1	Michaelis-Menten N2O reduction constant. If a value is provided here, this will overwrite the value read from the PARM1102.DAT file (see section on PARM1102.DAT for details).
12 (optional)	CBVT	Cumulative proportion of the BioVolume of spherical and cylindrical organisms. If a value is provided here, this will overwrite the value read from the PARM1102.DAT file (see section on PARM1102.DAT for details).

Figure 2 Example of the EPICRUN.DAT file open in a text editor.



EPICRUN.DAT - Notepad

File Edit Format View Help

```
TXBELLIB  72   0    0    0 249  16   0/
TXBUSHLA  167   0    0    0 558  53   0/
XXXXXXXX
TXPRAIRV  168   0    0    0 559  53   0/
KBK07000     1      1     0     1    11     2      1   5.000 0.50 0.01 0.01
KBK07045     1      1     0     1    11     3      1   5.000 0.50 0.01 0.01
```

Windows (CRLF) | Ln 7, Col 1 | 100%

In the example reported in Figure 2, EPIC will perform a simulation for the first two studies in the list (i.e., TXBELLIB and TXBUSHLA). The "XXXXXXXX" line stops the model from executing the remaining runs. Note the slash symbol at the end of the first, second, and third run where the optional fields 9, 10, 11, and 12 are not provided. The optional fields are provided in the last two runs. Also, because the EPIC reads this file as free format (i.e., space delimited), there is no need to have the fields aligned in columns (but this would be much more elegant and easier to read by the user like in the last two studies in the example).

EPIC control file (EPICCONT.DAT)

File format: different formats are used to read the EPICCONT.DAT file.

Line 1 – 2: space delimited; 20 fields (integer) each line

Line 3 – 6: space delimited; 10 fields (floating with 2 decimal digits) each line

The EPICCONT.DAT file contains several variables used to set the simulation and that will be held constant for all the simulations selected from the EPICRUN.DAT file.

Control file - Line 1

Line - Field	Variable name	Description
L1 – F1	NBYR	Number of Years for Simulation Duration The number of years can be any number from 1 to hundreds of years; however, 20 to 30 years may be adequate to estimate frequency distributions used to solve many problems. *(Range: 1 to 999)*
L1 – F2	IYR0	Beginning Year of Simulation If the starting year is before the first year of the historical weather data, ALL weather will be generated. Once the model starts generating weather, it continues until the end of the simulation. For example, if the historical weather data begins on Jan. 1, 1960, and the simulation begins on Jan. 1, 1956, then all the weather will be generated starting on Jan. 1, 1956, to the end of the simulation period. If the simulation period starts on a year included in the historical weather file, but the weather data does not extend for the complete simulation period, weather will be generated from the point the historical weather data ends to the end of the simulation period. For example, if the historical weather data begins on Jan. 1, 1960, and extends to Dec. 31, 2000, and the simulation period is from Jan. 1, 1996, to Dec. 31, 2005, then generated weather will be used beginning Jan. 1, 2001, and continue to the end of the simulation period (Dec. 31, 2005). *(Range: 1880 to 9999)*
L1 – F3	IMO0	Beginning Month of Simulation Most long-term simulations start on January 1. Starting after January 1 may be convenient for simulating systems where data are only recorded during the growing season. *(Range: 1 to 12)*

Line - Field	Variable name	Description
L1 – F4	`IDA0`	Beginning Day of Simulation Most long-term simulations start on January 1. Starting after January 1 may be convenient for simulating systems where data are only recorded during the growing season. *(Range: 1 to 31)*
L1 – F5	`IPD`	Print Code for Type of Output The print code (IPD) allows the user to print daily, monthly, or annual output, with or without printing tables describing soil conditions printed in the General Output File (OUT). Annual printouts minimize output volume and may be useful for some long-term simulations. Monthly outputs enable the user to evaluate model performance within the growing season or to examine seasonality of runoff, erosion, and other processes more closely than with annual printouts. Monthly outputs are normally obtained in short-term (1-10 year) simulations and are particularly useful in model testing. Daily outputs are also useful for model testing and for comparison with detailed experimental data. To obtain the desired type of output, IPD can be set to values from 0 to 9, as described below. Allowed values: N0 for annual watershed output N1 for annual printout N2 for annual with soil table N3 for monthly N4 for monthly with soil table N5 for monthly with soil table at harvest N6 for n day interval N7 for soil table only n day interval N8 for n day interval, rainfall days only N9 for n day interval during growing season For IPD 0 to 5, N = 0 prints management operation, N = 1 prevent printing management operation. For IPD 6 to 9, N = days interval to prints output in the OUT file. Management operations always printed.

Line - Field	Variable name	Description
L1 – F6	NGN	Input Code for Weather Variables EPIC can read one or more daily weather variables from an external file specified by the user. The weather input code, NGN, specifies which variables will be read; all others will be generated by APEX's stochastic weather data generator. If NGN is not set to zero, precipitation is read from the external file designated in the EPICRUN.DAT file. In addition to precipitation, any combination of the other daily weather variables can be read. The integers 1 through 5 are used to identify specific weather inputs that must be read from the selected daily weather file, as follows: 1 Precipitation 2 Maximum and minimum temperatures 3 Solar radiation 4 Average wind speed 5 Average relative humidity If any daily weather variables are input, precipitation must also be input. Thus, it is not necessary to specify ID=1 unless rain is the only input variable Example values of NGN are given below. NGN=0: Generate all weather variables (spatially distributed). NGN=1: Read precipitation; generate other variables. NGN=2: Read maximum and minimum temperatures and precipitation; generate other variables. NGN=3: Read solar radiation and precipitation; generate other variables. NGN=4: Read wind speed and precipitation; generate other variables. NGN=5: Read relative humidity and precipitation; generate other variables. NGN=23: Read maximum and minimum temperatures, solar radiation, and precipitation; generate wind speed and relative humidity. NGN=2345: Read all weather variables. NOTE: If weather data is not available for selected parameters, weather data is automatically generated. The model will use all available data for the selected parameters and generate when data for those select parameters is missing.

Line - Field	Variable name	Description
L1 – F7	IGN	Number of Times Random Number Generator Cycles Before Simulations Starts The random number generator is used to generate stochastically a series of daily weather data for input into other components of APEX. By changing IGN, the user can alter the sequence of generated weather data without changing its long-term statistical properties. Default setting: 0 *(Range: 0 to 100)* In some situations, a user may wish to vary the weather sequence between runs. This is done by setting IGN to a different number each time the model is run. Setting IGN to a value greater than zero will activate a random number generator, which will replace the default set of random numbers with a new set. The value to which IGN is set determines the number of times the random number generator cycles before the simulation begins. The seeds produced by the random number generator are then used by the weather generator instead of the default values. Historical weather data read into the model is not affected by this variable. However, if the historical weather data contains missing data, the weather generator will be used to generate data to replace the missing data. The generated data used to replace the missing data is affected by this variable. If IGN and the monthly weather statistics are not changed, successive simulations will have identical weather sequences.
L1 – F8	IGS0	Day Weather Generator Stops Generating Daily Weather This variable is used for real time simulations. When IGS0 is a negative integer, it indicates the total number of whole and partial years of input weather data. Normally, only a partial year (January 1 to planting date, for example) of measured weather data are used, thus IGS0 = -1. To estimate 20 alternative yield possibilities using input weather data for only part of a year, set NBYR to 20 and IGS0 to -1. *(Range: -N to 366)* 0 Normal operation of weather model N Duplicate weather in a given year up to date n -N Rewinds weather after n years 366 Gives a rough estimate of the average yield with only two years of simulation.

Line - Field	Variable name	Description
L1 – F8 (cont.)	IGS0 (cont.)	IGS0 can also be used to simulate yield where the same weather data set is used many times. For example, if IGS0 is set to -3, this tells the model to reuse the three years of input weather data then rewind and use it again multiple times until NBYR is met.
L1 – F9	LPYR	Leap Year Considered Allowed values: 0 Leap year is considered. 1 Leap year is ignored. Tells the model to expect only 365 days of input weather data and generate only 365 days of weather ignoring February 29th. ATTENTION: In this case, February 29th must be deleted from the weather input file.
L1 – F10	IET	Potential Evapotranspiration Equation Approach This field enables the user to choose which equation will be used to estimate the potential evapotranspiration (PET). Allowed values: 0 *(default) Hargreaves 1 *Penman-Monteith (usually for windy conditions). Adds a logarithmic eddy diffusion function and canopy resistance to the Penman equations. This option works best when measure data for all the weather variables are available. 2 *Penman. Adds relative humidity, wind speed, and elevation of wind measurements to the required weather inputs. This option works best when measure data for all the weather variables are available. 3 Priestley-Taylor. Requires radiation, as well as temperature as an input. 4 Hargreaves. Has two parameters which can be adjusted to calibrate the model for factors such as proximity to a major water body. 5 Baier-Robertson. Developed in cold environment. * Requires the entry of elevation (ELEV), monthly mean wind velocities (WVL). These equations also need relative humidity; however, if relative humidity is blank, EPIC will estimate relative humidity. Dew point can also be used.

Line - Field	Variable name	Description
L1 – F11	`ISCN`	Stochastic CN Estimator Code The final step in EPIC's estimation of runoff volume is an attempt to account for uncertainty. The runoff retention parameter or curve number is based on land use, management, hydrologic soil group, land slope, soil water content and distribution. It is also adjusted for frozen soil. However, many natural processes and management factors that can affect runoff are not accounted for in the model. EPIC enables the user to use either a deterministic or a stochastic method of estimating CN. If the deterministic method is chosen, the curve number is adjusted daily for soil water content (and frozen soil). If the stochastic method is chosen, the deterministic value is varied stochastically on a daily basis using a triangular distribution. The extremes of the distribution are +/- 5 curve numbers from the mean. Allowed values 0 Stochastic curve number estimator (default) 1 Rigid curve number estimator (Deterministic)
L1 – F12	`ITYP`	Peak rate estimate code Types I and IA represent the Pacific maritime climate with wet winters and dry summers. Type III represents Gulf of Mexico and Atlantic coastal areas where tropical storms bring large 24-hour rainfall amounts. Type II represents the rest of the country. For more precise distribution boundaries in a state having more than one type, contact the SCS State Conservation Engineer (SCS 1986). Allowed values: 0 For modified rational EQ peak rate estimate >0 For SCS TR55 peak rate estimate 1 For type I rainfall pattern 2 For type IA rainfall pattern 3 For type II rainfall pattern 4 For type III rainfall pattern

Line - Field	Variable name	Description
L1 – F13	`ISTA`	Static soil profile This code is used to allow EPIC to estimate soil erosion but not change the soil profile other than readily available nutrients and water. With this option set at 1, the subroutines for the estimation of soil erosion are not called during the simulation and the soil characteristics related to the organic carbon and nitrogen content are set to the initial values at the end of each year. In this way, it is possible to simulate multiple years of weather on the same soil and estimate erosion under alternative weathers. Allowed values: 0 For normal erosion soil profile 1 For static soil profile
L1 – F14	`IHUS`	Automatic heat unit scheduling Based on potential heat units (PHU) In the first year of the run, all operations are assigned a heat unit fraction based on the total number of heat units input at planting and dates assigned to each operation. Calculation of heat units is based on monthly weather statistics. In the following years all operations will occur based on the heat unit schedule assigned to them. This can be used to help adjust operations to the weather (temperatures) from year to year. Operations occurring from planting to harvest are based on heat units set at planting. Operations occurring before planting are based on total annual heat units, which are calculated by the model. Allowed values: 0 Normal operation 1 Automatic heat unit schedule (Number of growing degree units needed for crop to reach maturity (PHU) must be input at planting)
L1 – F15	`IRRS`	Simulation of root respiration Activates the simulation of root respiration in the denitrification subroutine NDNITCI. This option works only with the Cesar Izaurralde's denitrification method (IDN = 3 or IDN = 4). Allowed values: 0 Root respiration calculated in NDNITCI 1 Root respiration not considered in NDINITCI

Line - Field	Variable name	Description
L1 – F16	`NVCN`	Non-varying CN-CN2 used Allowed values: 0 Variable daily CN nonlinear CN/SW with depth soil water weighting (Use Parm 81 to adjust) 1 Variable daily CN nonlinear CN/SW without depth weighting 2 Variable daily CN linear CN/SW no depth weighting 3 Non-varying CN – CN2 used for all storms 4 Variable daily CN SMI (soil moisture index)
L1 – F17	`INFL0`	Runoff (Q) estimation methodology Allowed values: 0 CN estimate of Q 1 Green & Ampt (G&A) estimate of Q, Rainfall Exponential Distribution, Peak Rainfall Rate simulated 2 G&A estimate of Q, Rainfall Exponential Distribution, Peak Rainfall Input 3 G&A estimate of Q, Rainfall uniformly distributed, Peak RF Input
L1 – F18	`MASP`	Pesticide in output report Allowed values: -1 For mass only no pesticide in .OUT file 0 For mass only, pesticides in .OUT file 1 For pesticide and nutrient output in mass and concentration
L1 – F19	`LBP`	Soluble phosphorus runoff estimate equation Allowed values: 0 For soluble phosphorus runoff estimate using GLEAMS pesticide equation 1 For modified nonlinear approach
L1 – F20	`NSTP`	Real time day of year (Columns 77-80) Day of year selected to be the stopping point up until which weather, crop growth, etc. are known. The remainder of the year is projected. *(Range: 0 to 365)*

Control file – Line 2

Line - Field	Variable name	Description
L2 – F1	`IGMX`	Number of times generator seeds are initialized for a site *(Range: 1 to 100)*
L2 – F2	`IERT`	Enrichment Ratio Method Sets the method to simulate organic material lost in runoff. Allowed values: 0 EPIC enrichment ratio method 1 GLEAMS enrichment ratio method
L2 – F3	`ICG`	Crop growth biomass conversion method Allowed values: 0 Traditional EPIC radiation to biomass conversion 1 New experimental water-use to biomass conversion NOTE: If the water use to biomass approach is selected, value for variable WUB in EPIC in plant list file (CROPCOM.DAT) must be provided.
L2 – F4	`LMS`	Code for liming operation EPIC enables the user to simulate application of agricultural limestone to increase soil pH and/or reduce soil aluminum saturation. For many soils and applications of EPIC, this feature is not needed; therefore, it can be turned off by setting LMS to 1. Long term simulations with noncalcareous soils and either nitrogen fertilizer or nitrogen-fixing legumes often requires liming to prevent acidification of the soil and reduction of crop growth. Allowed values: 0 For automatic lime application as needed to prevent acidification of the soil 1 No lime applied

Line - Field	Variable name	Description
L2 – F5	`ICF`	C factor selector for erosion equation Allowed values: 0 To use RUSLE C factor for all erosion equations 1 To use EPIC C factor for all erosion equations except RUSLE
L2 – F6	`ISW`	Field capacity and wilting point estimation method ISW allows the user to select the method used to provide values for the soil water content at field capacity (FC) and wilting point (WP). Allowed values: 0 Dynamic FC and WP estimated with Rawls method. 1 Dynamic FC and WP estimated with Baumer method. 2 Dynamic FC and WP estimated with Rawls method starting with input data. FC and WP data must be provided in the soil file. 3 Dynamic FC and WP estimated with Baumer method starting with input data. FC and WP data must be provided in the soil file. 4 Static FC and WP estimated with Rawls method. FC and WP are estimated and kept constant for the entire simulation. 5 Static FC and WP estimated with Baumer method. FC and WP are estimated and kept constant for the entire simulation. 6 Static input FC and WP. Data provided in the soil files are kept constant for the entire simulation. 7 Dynamic FC and WP estimated with the nearest neighbor method. The input file SOIL35K.DAT must be provided. 8 Static FC and WP estimated with the nearest neighbor method. FC and WP are estimated and kept constant for the entire simulation. The input file SOIL35K.DAT must be provided. 9 Dynamic FC and WP estimated with the Behrman-Norfleet-Williams (BNW) method (Behrman, Norfleet, & Williams, 2016). 10 Static FC and WP estimated with the Behrman-Norfleet-Williams (BNW) method. FC and WP are estimated and kept constant for the entire simulation (Behrman et al., 2016).
L2 – F7	`IRW`	Daily weather data usage option When set to zero, the model uses the daily weather input data as usual. If set to one, the model will use the weather station set in the first run for all the subsequent runs. Moreover, when going from one run to the next one, the weather data will be read continuously. For example, if for run 1 the user selects 2 years of simulation starting in 2001, the model will use weather data of the appropriate weather station (let's call it station A). Data from 2001 for the first

Line - Field	Variable name	Description
L2 – F7 (cont.)	`IRW` `(cont.)`	year and data from 2002 for the second year of simulation. If the subsequent run simulates a two-year period, data from station A will be used for this simulation and data from 2003 will be used for the first year of simulation and from 2004 for the second year of simulation. Allowed values: 0 For normal runs with daily weather input 1 For continuous daily weather from run to run (no rewind)
L2 – F8	`ICO2`	Atmospheric CO_2 concentration ICO2 allows to set the dynamic of the atmospheric CO_2 concentration during the simulation. Allowed values: 0 For constant atmospheric CO_2 concentration. CO_2 concentration must be provided with variable CO20 or variable CO2X. 1 For dynamic atmospheric CO_2 concentration. The initial CO_2 concentration is calculated by EPIC and is increased linearly during the simulation. 2 For inputting the atmospheric CO_2 concentration in the daily weather file. See the daily weather file section for more details.
L2 – F9	`NTV`	Nitrogen volatilization method NTV allows to select the method used to simulate nitrogen volatilization. Allowed values: 0 Original EPIC nitrogen volatilization equations 1 Revised nitrogen volatilization equations by C. Izaurralde
L2 – F10	`ICOR`	Southern oscillation correction If greater than zero, it sets the day of the year when the weather correction to simulate input monthly average values stops. Works only if multi-run option is activated. When activated, the values for temperature and precipitation in the WP1 file are corrected using the observed daily weather data used during the simulation. *(Range: 0 – 365)* 0 Normal run – no southern oscillation >0 Day of the year when southern oscillation correction to simulate input monthly means stops

Line - Field	Variable name	Description
L2 – F11	`IDN`	Denitrification method code Selects the approach used to simulate the denitrification process. Allowed values: 1 Original EPIC denitrification approach 2 Armen Kemanian's denitrification approach 3 Cesar Izaurralde's denitrification approach (original DW) (R. C. Izaurralde et al., 2017) 4 Cesar Izaurralde's denitrification approach (new DW) (R. C. Izaurralde et al., 2017)
L2 – F12	`NUPC`	Nitrogen and Phosphorus plant uptake concentration code Selects the approach used to estimate the optimal N and P plant concentration. Allowed values: 0 Smith curve 1 S-curve
L2 – F13	`IOX`	Oxygen – depth function code Selects the method used to estimate the oxygen concentration in the soil. Allowed values: 0 For original EPIC oxygen/depth function 1 For Armen Kemanian's carbon/clay function 2 For new oxygen ratio method
L2 – F14	`IDI0`	Data directory Selects from where to read the input data. Allowed values: 0 For reading data from the working directory 1 For reading data from weather directory 2 For reading data from working directory plus 3 other directories.
L2 – F15	`ISAT`	Saturated conductivity code ISAT allows the user to select if the soil saturated conductivity is provided in the soil file or if it must be estimated by the model. Allowed values: 0 For reading saturated conductivity from the soil profile data 1 For computing saturated conductivity with Rawls method

Line - Field	Variable name	Description
L2 – F16	IAZM	Latitude source code Allowed values: 0 For using input latitude for the field 1 For computing equivalent latitude based on azimuth orientation of land slope
L2 – F17	IPAT	Auto phosphorus fertilization code Turn on or off the automatic application of P. Allowed values: 0 Turn off auto-phosphorus fertilization 1 Turns auto-phosphorus fertilization on
L2 – F18	IEVI	Photosynthetic Active Radiation (PAR) estimation approach IEVI is used to select how the PAR is estimated during the simulation. Allowed values: 0 PAR driven by crop LAI development. 1 PAR driven by EVI from remote sensing. If IEVI is set equal to one, vegetation index (EVI) obtained from remote sensing must be input in the daily output file as eighth variable.
L2 – F19	IPRK	Soil water percolation method IPRK allows the user to select the method to estimate the soil water percolation during the simulation. Allowed values: 0 For original EPIC approach. 1 For Variable Saturation Hydraulic Conductivity (VSHC) method (Doro et al., 2018)
L2 – F20	ICP	Carbon/Nitrogen Mineralization Method Selects the method used to simulate the soil organic carbon and nitrogen dynamics. Allowed values: 0 For the Phoenix approach (McGill, Hunt, Woodmansee, & Reuss, 1981) 1 For the Century approach (R. Izaurralde, Williams, McGill, Rosenberg, & Jakas, 2006)

Line - Field	Variable name	Description
L2 – F21	`ISLT`	**Soil temperature simulation method** Selects the approach used to simulate the soil temperature. For more information see (Doro et al., 2021) Allowed values: 0 For original EPIC cosine function (SOLT subroutine) 1 For enhanced cosine function (subroutine SOLT_eCOS) 2 For temperature transfer approach (subroutine SOLT_TT)

Control file – Line 3

Line - Field	Variable name	Description
L3 – F1	`RFN0`	**Average concentration of nitrogen in rainfall (ppm)** The average concentration of N in rainfall may vary slightly for different locations. However, since the rainfall N contribution is a relatively small component of the N cycle, a value of 0.8 ppm or mg N/liter is generally satisfactory. If site-specific information is available, the user is free to set the value appropriately. *(Range: 0.50* to *1.50)*
L3 – F2	`CO20`	**Carbon dioxide concentration in atmosphere (ppm)** The amount of carbon dioxide in the atmosphere (ppm) used to begin the simulation. See variable ICO2 for atmospheric CO_2 concentration options. *(Range: 0* to *1000)*
L3 – F3	`CNO30`	**Concentration of NO3-N in irrigation water (ppm)** The amount of mineral nitrogen in irrigation water. *(Range: 0* to *1000)*

Line - Field	Variable name	Description
L3 – F4	CSLT	Salt concentration in irrigation water (ppm) The amount of salt in irrigation water. For reference, the irrigation water is classified as low salinity (0-456 ppm), moderately salty (456-1425 ppm), salty (1425-2850 ppm), and very salty (>2850 ppm). *(Range: 0 – ∞)*
L3 – F5	PSTX	Pest damage scaling factor The factor scales the growth of pests (insects and diseases only) in terms of population growth. It ranges from 0 (no pest growth; pest damage function is shut off) to 10 (maximum pest growth). Under default conditions this parameter is set to 1.00 which produces only minimal pest growth and does not affect yield. This parameter works in conjunction with PARM(9), PARM(10), S-curve parameter 9 in the EPIC parameter file (PARM1102.DAT), and variable PST in the EPIC plant list file (CROPCOM.DAT). Pest damage function can be regulated from very mild (0.05-0.10) to very severe (1.00-10.00). *(Range: 0* to *10)*
L3 – F6	YWI	Number years of maximum monthly 0.5-hour rainfall available Can be obtained from the U.S. Department of Commerce (0 if WI is not imputed). Default setting: 10 *(Range: 0* to *20)*
L3 – F7	BTA	Coefficient governing wet-dry probabilities given days of rain Used to estimate wet-dry rainfall probabilities if information is only available for the average monthly number of wet days. Generally, the number of wet days is much more readily available than the wet-dry rainfall probabilities. A value of 0.75 for BTA usually gives satisfactory estimates of the wet-dry probabilities. May be left zero if daily rainfall is inputted. May be left zero if rainfall is generated and wet-dry probabilities are input. Default setting: 0.75 *(Range: 0 to 1)*

Line - Field	Variable name	Description
L3 – F8	EXPK	Parameter used to modify exponential rainfall amount distribution The modified exponential distribution is used to generate rainfall amounts if the standard deviation and skew coefficient are not available. An EXPK value of 1.3 gives satisfactory results in many locations. May be left 0.0 if unknown or if standard deviation of rainfall and skew coefficient for daily precipitation are input. Default setting: 1.3 *(Range: 0 to 2)*
L3 – F9	FL	Field length (if wind erosion is to be considered) in kilometers If the normal wind erosion calculation is to be utilized (Wind Erosion Adjustment Factor (ACW) = 1), field dimensions and orientation must be specified. This variable refers to the length of the field that is exposed to the wind. Without trees, FL = length of the field. With trees, FL < length of the field. If wind erosion is simulated for specific sites, FL, FW, and ANG can be measured easily. However, hypothetical sites are often used in long-term simulations associated with large-scale decision making. In such cases, values of FL, FW, and ANG should be chosen to represent typical field configurations of the area. Efforts to match field dimensions and drainage area are not necessary. The field dimensions are used only to estimate wind erosion, with the exception that FL is used to estimate water erosion from furrow irrigation. Thus, the simulation site may be a small area (1 ha) in a field of 1.0 by 0.5 km. It should be noted that the change in simulated wind erosion is not large for any FL > 0. 3 km. Therefore, estimations of FL and FW are not usually critical for fields with areas greater than about 10 ha. When fields larger than 10 ha are strip cropped, however, the estimation of FW becomes more important. To evaluate the effect of strip cropping, FW is estimated as the average width of the strips. If FL is set to zero, a value of 0.632 is assigned by default. *(Range:0.001 to ∞)*
L3 – F10	FW	Field width (if wind erosion is to be considered) in kilometers See variable FL for further information. If FW is set to zero, a value of 0.316 is assigned by default. *(Range: 0.001 to ∞)*

Control file – Line 4

Line - Field	Variable name	Description
L4 – F1	ANG0	Clockwise angle of field length from north (deg) It is used only if wind erosion is simulated. If ANG is known, enter the value in degrees. It can be left at zero if the simulation of wind erosion is not needed. *(Range: 0 to 360)*
L4 – F2	STD0	Standing dead crop residue (Mg ha^{-1}) Standing dead crop residue present at the beginning of the simulation. STD0 can be left at zero if unknown, however, year one will not have standing dead residue prior to crop growth. Crop residue will be present only after the first crop cycle. *(Range: 0 to 1000)*
L4 – F3	UXP	Power parameter of modified exponential distribution of wind speed (if wind erosion is to be considered) The power parameter of the modified exponential wind speed distribution ranges from about 0.3 to about 0.7. A value of 0.50 usually gives satisfactory estimates of daily wind speed. UXP may be left at 0.0 if unknown, and it will be set to the default value of 0.50. *(Range: 0 to 1)*
L4 – F4	DIAM	Soil particle diameter (micron µm) It is used only if wind erosion is simulated. Normally this value ranges from 300 to 500 µm (sands). DIAM may be left at 0.0 if unknown and it will be set to its default value of 500.0. *(Range: 100 to 500)*
L4 – F5	ACW	Wind erosion adjustment factor The wind erosion adjustment factor is used along with PEC values to shut off or accelerate soil erosion. As with water erosion, wind erosion can be shut off by setting ACW = 0. If normal wind erosion calculation is desired, set ACW = 1. Also, AWC can be increased to a high level (e.g. ACW=10) as a shortcut in estimating wind erosion effects on the soil profile. Since ACW is related linearly to wind erosion, 1000year' simulation can be approximated by 100 years' simulation using ACW=10. *(Range: 0 – 10)*

Line - Field	Variable name	Description
L4 – F5 (cont.)	`ACW` `(cont.)`	ACW = 0 No wind erosion ACW = 1 Normal simulation ACW > 1 Accelerates wind erosion (condenses time)
L4 – F6	`BIR`	Water stress factor to trigger automatic irrigation BIR is used to trigger automatic irrigation based on selected aspects during the simulation. BIR allows us to select different methods to activate the automatic irrigation considering aspects such as plant water stress or soil water content measured in different ways. The following scheme provides detailed information on how to set BIR to select the method and set the threshold to activate the automatic irrigation. BIR = 0 — Only manual irrigation will be used during the simulation. BIR 0 – 1.0 — Automatic irrigation based on plant water stress factor. The dimension (1 – BIR) equals the fraction of plant water stress allowed. Consequently, a low BIR allows high plant water stress before triggering automatic irrigation. BIR = 1.0 — Does not allow water stress. BIR < 0.0 — Automatic irrigation triggered by plant available water deficit in root zone. Number is in mm and must be negative. BIR > 1.0 — Automatic irrigation triggered by soil water tension in top 200 mm of the soil profile. Absolute number is in kilopascals. BIR -1000 — Sets water deficit high enough that only manual irrigations will occur. Effectively turns auto irrigation off. NOTES • When BIR is set and used with a cropping system that includes more than one crop in rotation, the BIR will apply to all crops in the rotation. • When using a BIR based on anything other than plant water stress (0-1), be aware that irrigation will be applied outside of the growing season if the soil water deficit or soil water tension reaches BIR. This will reduce the amount of water available for irrigation during the growing season.

Line - Field	Variable name	Description
L4 – F7	`EFI`	Runoff volume/Volume irrigation water applied The irrigation runoff ratio specifies the fraction of each irrigation application that is lost to runoff. Soluble nutrient loss through runoff applies. Changes in soil slope do not affect this amount dynamically. EFI must be set accordingly, and the irrigation method should be considered. Set to 0 if IRR = 0 (dryland). *(Range: 0 to 1)*
L4 – F8	`VIMX`	Maximum annual irrigation volume (mm) This is the maximum irrigation volume allowed each year in mm. If several crops are grown in one year, the first crop's needs will be supplied as needed and any remaining water will be applied as needed to the next crop. If all of the water allocated by VIMX is used on the first crop, the second crop will not receive any irrigation. This also applies to manual irrigation. Once the amount of irrigation applied equals VIMX, then no additional irrigation will be applied, regardless of if it is manually or automatically applied.
L4 – F9	`ARMN`	Minimum single application volume (mm) This is the minimum amount of irrigation allowed for each auto irrigation application.
L4 – F10	`ARMX`	Maximum single application volume (mm) This is the maximum amount of irrigation allowed for each auto irrigation application in mm. This is the amount of irrigation water applied if rigid automatic irrigation is selected.

Control file – Line 5

Line - Field	Variable name	Description
L5 – F1	`BFT0`	Nitrogen stress factor to trigger auto fertilization The automatic fertilizer trigger functions like BIR for irrigation. When the plant nitrogen stress level reaches BFT0, nitrogen fertilizer may be applied automatically. If BFT0 is greater than 0, IDF0 must be the Number of the fertilizer selected for the automatic N application.

Line - Field	Variable name	Description
L5 – F1 (cont.)	BFT0 (cont.)	The auto N fertilization can be activated as follows: BFT0 = 0.00 For manual fertilizer application. BFT0 0 – 1 Allows percentage of plant nitrogen stress with the dimension (1 – BFT) equals the fraction of nitrogen stress allowed. BFT0 = 1.00 No nitrogen stress allowed; auto-fertilization is triggered when needed. BFT0 > 1.00 If BFT0 is greater than 1, BFT0 is the ppm (g Mg^{-1}) of nitrogen in soil at which automatic fertilization is triggered.
L5 – F2	FNP	Fertilizer application variable FNP has two meanings: • If the automatic fertilization is activated, a value greater than 1 will set the fixed amount of fertilizer applied with each automatic application. The value is input as kg ha^{-1}. • If irrigation from lagoon is selected (IRR = 4) FNP indicates the manure input to lagoon in kg/cow/day. If this option is used, the part for automatic fertilization is skipped. To use this option, variables RST0, FFED, VLGN, DDLG, COWW, and SOLQ (below in this section) must be provided.
L5 – F3	FMX	Maximum annual N fertilizer applied for a crop (kg ha^{-1}) Maximum amount of nitrogen fertilizer available for application per plant (for annual plants) or per year (for perennial plants and trees). After FMX value has been met, no additional fertilizer will be applied. This variable can be overridden in the operation schedule where it can be set for each planting operation. Refer to section on the EPIC management file (*filename*.OPC) for further information on setting the maximum annual amount per crop. If FMX is set to zero it is default to 200. NOTE If this variable is set either in the control table file or in the operation schedule and manual fertilization is applied, the model will only apply up to this maximum amount regardless of the amount specified in the manual fertilization operation.

Line - Field	Variable name	Description
L5 – F4	DRT	Time requirement for drainage system to end plant stress in days Artificial drainage systems may be very efficient and quickly reduce soil water content or it may take several days for the soil water level to decline sufficiently to eliminate aeration stress. The variable DRT is used to specify the time needed for the drainage system to eliminate stress. In this case time is measured in days. Enter 0 if drainage is not considered. *(Range: 0 to 365)*
L5 – F5	FDS0	Furrow dike safety factor Fraction of furrow dike volume available for water storage. FDS0 controls the volume of water that can be stored in the dike before water tops over the dike. This variable is used to account for uncertainty in the volume of the furrow dike. The volume is calculated from the height of the row, row interval (width of row), length of dike and height of dike. If these values are not very certain, it may be wise to set FDS0 to a low number which indicates that the certainty of dike design in not very high. This will cause the dikes to overflow much quicker, which will affect runoff and erosion. If the certainty of design of the dike is great, FDS0 can be set to 0.9 or higher, which will lessen dike overflow as well as runoff and erosion. *(Range: 0 to 1)*
L5 – F6	PEC0	Erosion control practice factor The erosion-control-practice factor normally ranges from about 0.1 to 0.9 depending upon the effectiveness of the conservation practice. Default = 1.0 for non-contoured fields. However, PEC can be set to 0.0 to eliminate water erosion entirely. At the other extreme, (PEC = 10.0) erosion rates are increased 10 times to improve long-term simulation efficiency. This feature is a big time-saver in estimating water erosion effects on soil properties over periods of up to 1000 years. Obviously, the 1000-year period can be approximated with a 100-year simulation using PEC = 10.0. *(Range: 0 to 10)*
L5 – F7	VLGN	Lagoon volume ratio Normal Lagoon Volume as a fraction of Maximum Lagoon Volume (Normal Lagoon Volume/Maximum lagoon volume). It is needed only when IRR = 4. *(Range: 0 to 1)*

Line - Field	Variable name	Description
L5 – F8	`COWW`	Lagoon input from wash water (m^3/cow/day) Needed only when IRR = 4 and owner has at least one head of livestock. Average normal value is 0.15. *(Range: 0 to 1)*
L5 – F9	`DDLG`	Time to reduce lagoon storage from maximum to normal (number of days) Needed only when IRR = 4. *(Range: 0 to 365)*
L5 – F10	`SOLQ`	Ratio liquid/total manure produced in this feedlot subarea Fraction of total manure produced that goes into a lagoon as liquid. Needed only when IRR = 4 *(Range: 0 to 1)*

Control file – Line 6

Line - Field	Variable name	Description
L6 – F1	`GZLM`	Above ground plant material grazing limit (Mg ha^{-1}) This Is the minimum amount of biomass present in the field to allow grazing activity. The grazing activity stops when the above ground biomass goes below the threshold set with GZLM.
L6 – F2	`FFED`	Fraction of day (24 hours) that herd is in feeding area This is the fraction of the day that herd is in the feeding area and not grazing on pasture. *(Range: 0 to 1)*
L6 – F3	`DZ`	Layer thickness for solution of gas diffusion differential equation (m) This information is used only when the Cesar Izaurralde denitrification approaches (see IDN > 2 on line two of the EPIC control file) are selected by the user.

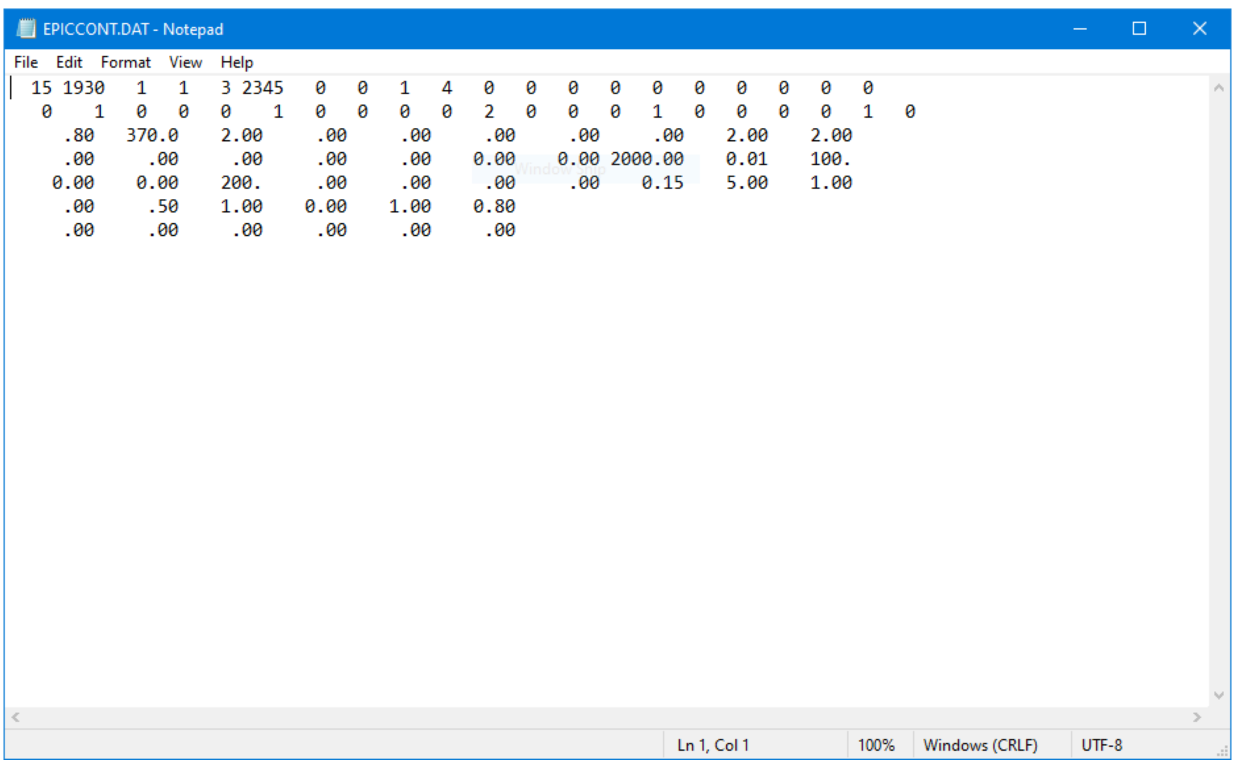
Line - Field	Variable name	Description
L6 – F4	`DRV`	Water erosion driving equation code Specifies the equation used in simulating the water erosion process and interacts with all the EPIC components. In fact, EPIC simulates soil water erosion with all the methods available but only the results obtained with the methods selected by the user interact with the other components of the EPIC model. Allowed values: 0 MUST – Modified MUSLE theoretical equation 1 AOF - Onstad-Foster NOT AVAILABLE 2 USLE - Universal Soil Loss Equation 3 MUSS - Small Watershed MUSLE 4 MUSL - Modified USLE 5 MUSI - MUSLE with input parameters (see BUS(1)) NOT AVAILABLE 6 RUSL – Revised Universal Loss Equation 7 RUS2 – Modified Revised Universal Loss Equation
L6 – F5	`RST0`	Base stocking rate (hectares per head) Indicates the number of hectares available per grazer.
L6 – F6	`STF0`	Fraction of storage interacting with nitrate leaching It defines the fraction of soil porosity that is considered in estimating nitrogen leaching. It is overwritten by values provided in the soil file (variable STRF). Default setting: 0.8 *(Range: 0.05 to 1)*

Control file – Line 7

Line - Field	Variable name	Description
L7 – F1	`COIR`	Cost of irrigation water (\$ m^{-3}) This is the cost of water used for irrigation.
L7 – F2	`COL`	Cost of lime (\$ Mg^{-1}) Cost of one metric ton (equal to one megagram - Mg) of lime.

Line - Field	Variable name	Description
L7 – F3	FULP	Cost of fuel ($ gal^{-1}) Cost of one gallon of fuel.
L7 – F4	WAGE	Cost of labor ($ hr^{-1}) Hourly cost of labor.
L7 – F5	CSTZ1	Miscellaneous cost ($ ha^{-1}) First of two additional costs available to the user.
L7 – F6	CSTZ2	Miscellaneous cost ($ ha^{-1}) Second of two additional costs available to the user.

Figure 3. Example of the EPICCONT.DAT file open in a text editor.




```
 15 1930    1    1    3 2345    0    0    1    4    0    0    0    0    0    0    0    0    0    0
    0    1    0    0    0    1    0    0    0    0    2    0    0    0    1    0    0    0    0    1    0
     .80   370.0    2.00     .00     .00     .00     .00     .00    2.00    2.00
     .00     .00     .00     .00     .00    0.00    0.00 2000.00    0.01    100.
    0.00    0.00    200.     .00     .00     .00     .00    0.15    5.00    1.00
     .00     .50    1.00    0.00    1.00    0.80
     .00     .00     .00     .00     .00     .00
```

EPIC site list file (SITECOM.DAT)

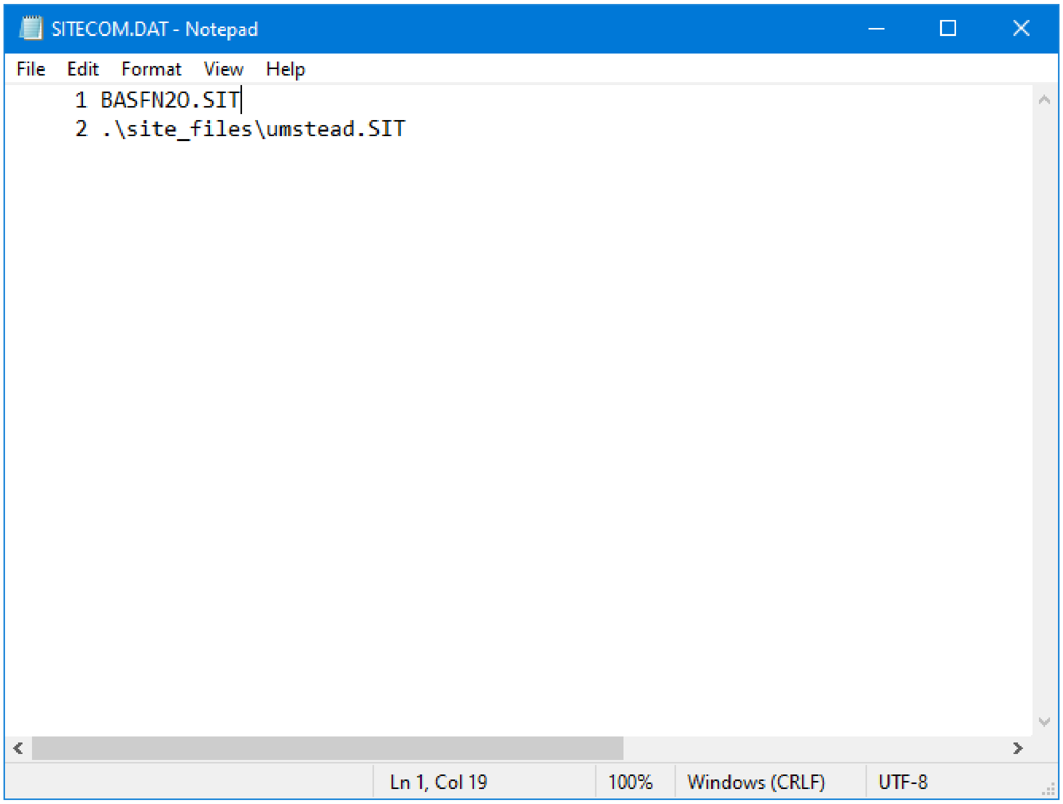
File format: space delimited.

The EPIC site list is a listing of all site files which have been created (see next section for details on how to create a site file) and are available for use in creating runs. The site list consists of a numbered listing of all site files which can be referenced by number in the EPICRUN.DAT file. The name of the site list file may be user defined; however, it must be properly identified in the EPICFILE.DAT file.

Table 3. Variables included in the EPIC site list file.

Site ID #	Site file name
Unique number to identify the site file. This number is used in EPICRUN.DAT file to select the site file for each simulation.	Name of the site file (including the extension of the file) or path + name of the site file (including the extension). When using the name of the site file, the site file must be in the same folder where the EPIC executable is located. When using the path + file name, no spaces can be included in the path.

Figure 4. Example of EPIC site list file. In this example, the site file BASFN2O.SIT is in the same directory of the EPIC executable while the site file "umstead.sit" is in the folder "site_files" which is in the same folder where the EPIC executable is.



EPIC site file (*filename*.SIT)

File format: different formats are used to read the EPIC site file.

Line 1 – 3: 20 alpha characters per line

Line 4: fixed format; 11 fields of 8 characters each (floating with 2 decimal digits)

Line 5: fixed format; 10 fields of 8 characters each (floating with 2 decimal digits)

Line 6: fixed format; 9 fields of 4 characters (integer)

A study may involve several sites (fields, farms, or watersheds), which can be listed in SITECOM.DAT (or user-defined name). Each site is described and saved with *filename*.SIT and includes general data that describe the location of the experiment.

Site file – Line 1-3

Three title lines are available for site description.

Site file – Line 4

Line - Field	Variable name	Description
L4 – F1	YLAT	Latitude of watershed in decimal degrees *(cols. 1-8)* The latitude of the field or watershed (YLAT) is used to estimate day length. It must be supplied by the user. Units are degrees. Latitudes in the Southern Hemisphere are in negative degrees and positive in the Northern Hemisphere. *(Range: -90 to 90)*
L4 – F2	XLOG	Longitude of watershed in decimal degrees *(cols. 9-16)* *(Range: -180 to 180)*
L4 – F3	ELEV	*Average watershed elevation in meters (cols. 17-24)* The average watershed elevation should be input if the Penman or the Penman-Monteith approach is used to estimate potential evapotranspiration. Units are meters. *(Range: -200 to 8000)*
L4 – F4	APM	Peak runoff rate – rainfall energy adjustment factor *(cols. 25-32)* The peak runoff-rate-rainfall energy adjustment factor provides a means for fine tuning the energy factor used in estimating water erosion. Normally, an APM value of 1 gives satisfactory results. Set APM to 0 if unknown. *(Range: 0 to 1)*

Line - Field	Variable name	Description
L4 – F5	`CO2X`	**Atmospheric CO_2 Concentration in ppm** *(cols. 33-40)* A non-zero value overrides the CO_2 input in EPICCONT.DAT. *(Range: 0 to 1000)*
L4 – F6	`CNO3X`	**Concentration of NO_3 in irrigation water in ppm** *(cols. 41-48)* A non-zero value overrides the CQN input in the EPICCONT.DAT. *(Range: 0 to 1000)*
L4 – F7	`RFNX`	**Average concentration of Nitrogen in rainfall in ppm** *(cols. 49-56)* A non-zero value overrides the RFN0 input in the EPICCONT.DAT *(Range: 0.5-1.5)*
L4 – F8	`X1`	**Dummy** *(cols. 57-64)*
L4 – F9	`X2`	**Dummy** *(cols. 65-72)*
L4 – F10	`SNO0`	**Water content of snow present on the ground at start of simulation in millimeters** *(cols. 73-80)*
L4 – F11	`AZM`	**Azimuth orientation of land slope (degrees clockwise from north)** *(cols. 81-88)* Used only if equivalent latitude is computed based on azimuth orientation of land slope (IAZM in EPICCONT.DAT greater than zero). *(Range: 0 to 360)*

Site file – Line 5

Line - Field	Variable name	Description
L5 – F1	`WSA`	**Field, farm or watershed area in hectares** *(cols. 1-8)* Size of the area to be simulated. A value for WSA is required and must be provided.
L5 – F2	`CHL`	**Mainstream channel length in kilometers** *(cols. 9-16)* Distance from outlet to most distant point on field, farm, or watershed.

Line - Field	Variable name	Description
L5 – F2 (cont.)	CHL (cont.)	Often in small areas there is no defined channel. In such cases the length is measured along a concentrated flow path, or it can simply be estimated from the length-width ratio of the watershed. For areas ≤ 20 ha, the channel length measurement is not critical. In such cases where channel data is not available, CHL can be set to 0 and allow the model to estimate it. If channel data is not available, enter 0 (TR55 file must be present as input file).
L5 – F3	CHS	Mainstream channel slope *(cols. 17-24)* The average channel slope is computed by dividing the difference in elevation between the field, farm, or watershed outlet and the most distant point by CHL. For small areas this measurement is not critical because CHL and CHS are only used in estimating the watershed time of concentration. The dominant portion of the time of concentration is involved with overland rather than channel flow in small watersheds. Slope is expressed as units of drop per unit of distance (m m^{-1}). If unknown, enter 0 (upland slope steepness (UPS) in site file must be provided).
L5 – F4	CHD	Channel depth *(cols. 25-32)* Depth of the channel in meters. If unknown, enter 0 (TR55 file must be present as input file).
L5 – F5	CHN	Manning's N for channel *(cols. 33-40)* If the channel conducting runoff to the edge of the field is winding and/or contains obstructions, water flow rates will be reduced, and sediment will have an opportunity to settle. The channel roughness factor is referred to as the Manning's "n" value. Table 4 contains suggested values of Manning's "n" for various condition channel flow (Chow, 1959). Chow has a very extensive list of Manning's roughness coefficients. These values represent only a small portion of those listed in his book. If unknown, enter 0 (the default value of 0.05 will be assigned to CHN).
L5 – F6	SN	Manning's N for upland (surface) *(cols. 41-48)* The surface roughness factor is Manning's "n" values. Table 5 contains suggested values and possible ranges of Manning's "n" for various condition overland flow (Engman, 1983). If unknown, enter 0 (the default value of 0.15 will be assigned to SN).

Line - Field	Variable name	Description
L5 – F7	UPSL	Average Upland Slope Length in meters *(cols. 49-56)* This value must be entered. The watershed slope length can be estimated by field measurement as described by Wischmeier and Smith (1978) or from topographic maps using the Contour-Extreme Point Method (R. J. Williams & Berndt, 1977). This is the distance that sheet flow is the dominant surface runoff flow process. Slope length should be measured to the point that flow begins to concentrate. This length is easily observable after a heavy rain on a fallow field when the rills are well developed. In this situation, the slope length is the distance from the subarea divide to the origin of the rill. This value can also be determined from topographic maps. Terraces divide the slope of the rill into segments equal to the horizontal terrace interval. With terracing, the slope length is the terrace interval. For broad base terraces, the horizontal terrace interval is the distance from the center of the ridge to the center of the channel for the terrace below. The horizontal terrace interval for steep backslope terraces is the distance from the point where cultivation begins at the base of the ridge to the base of the front slope of the terrace below. Slope length is a parameter that is commonly overestimated. As a rule of thumb, 90 meters (300 ft) is considered to be a very long slope length.
L5 – F8	UPS	Average Upland Slope *(cols. 57-64)* Slope is in m m^{-1}. Must be entered. The average watershed slope can be estimated from field measurement or by using the Grid-Contour Method (R. J. Williams & Berndt, 1977).
L5 – F9	PEC	Erosion control practice factor *(cols. 65-72)* The erosion-control-practice factor normally ranges from about 0.1 to 0.9 depending upon the effectiveness of the conservation practice. A non-zero value overwrites the PEC0 set in EPICCONT.DAT file. Default = 1.0 for non-contoured fields. PEC can be set to 0.0 to eliminate water erosion entirely.

Line - Field	Variable name	Description
L5 – F9 (cont.)	`PEC` `(cont.)`	At the other extreme, (PEC=10.) erosion rates are increased 10 times to improve long-term simulation efficiency. This feature is a big, time saver in estimating water erosion effects on soil properties over periods of up to 1000 years. Obviously, the 1000-year period can be approximated with a 100-year simulation using PEC=10. Table 6 provides P values and slope length limits for contouring. *(Range: 0 to 10)*
L5 – F10	`DTG`	Time interval for gas diff equations *(cols. 73-80)* This value is used when the Izaurralde denitrification approach is selected in EPICCONT.DAT (variable IDN > 2). For more information on the Izaurralde denitrification approach see Izaurralde et al. (2017).

Site file – Line 6

Line - Field	Variable name	Description
L6 – F1	`IRR`	Irrigation Code *(cols. 1-4)* The irrigation code is used to specify whether irrigation is used and the type of irrigation. It is composed of two digits: the first one (N in the example below) defines the irrigation mode, the second one defines the irrigation type. N = 0 flexible (variable) application. Applies the minimum of volume input, soil water field capacity (FC-SW) and maximum single irrigation application (ARMX). When used with the manual irrigation option, irrigation is applied on the date specified in the operation schedule in a volume equal to the minimum of the specified volume, the maximum single application volume, or the volume required to fill the root zone to field capacity (calculated as (FC-SW)/ (1-efficiency EFI)). When used with the automatic option, irrigation is applied based on the irrigation trigger (BIR) and according to the minimum (ARMN) and maximum (ARMX) single irrigation application rate as well as the maximum annual irrigation amount (VIMX) and the irrigation interval (IRI) with the volume applied that will not exceed the volume required to fill the root zone to field capacity. N = 1 rigid (fixed) application. Applies input amount or ARMX. If the manual irrigation is selected, irrigation is applied according to the amounts and dates specified in the operation schedule. If the automatic irrigation option is selected, the amount applied per irrigation is equal to the

Line - Field	Variable name	Description
L6 – F1 (cont.)	IRR (cont.)	maximum single application volume (ARMX) and it is applied when the irrigation trigger (BIR) is reached. In all cases, the EFI is removed through runoff prior to infiltration into the soil. Irrigation types available in EPIC are: N0 = for dryland areas N1 = for sprinkler irrigation N2 = for furrow/flood irrigation N3 = for fertigation (irrigation with fertilizer added) * N4 = for lagoon (irrigation from a lagoon) N5 = for drip irrigation For example, a rigid drip irrigation is coded as 15. A flexible sprinkler irrigation is coded as 01. In all cases, the N before the code for irrigation type indicates the irrigation mode. If furrow/flood irrigation is specified, water induced erosion is calculated. If fertigation is specified, IDF0 identifies the type of fertilizer (fertilizer ID from fertilizer table) and FNP identifies the amount of fertilizer for each irrigation. If lagoon is specified, IDF0 is used to identify the organic fertilizer while FNP represents the manure input to lagoon in kg/cow/day. * Fertigation works only when automatic irrigation and automatic nitrogen fertilization are selected. See BIR (line 4 of the EPIC control file) and BFT0 (line 5 of the EPIC control file). A way to manually simulate fertigation is to simulate irrigation and fertilization on the same day using the irrigation volume and amount of fertilizer added with the fertigation or using the automatic irrigation and setting the amount of N in irrigation water (see variables CNO30 and CNO3X).

Line - Field	Variable name	Description
L6 – F2	`IRI`	Minimum application interval for automatic irrigation *(cols. 5-8)* This sets the number of days between automatic irrigation events. Irrigation will not occur until the minimum number of days has been met regardless of the BIR has already been met. Because IRI will also affect manual irrigation, set IRI = 0 if automatic irrigation is not used (IRR = 0). *(Range: 0 to 365)*
L6 – F3	`IFA`	Minimum fertilizer application interval for auto option *(cols. 9-12)* This sets the number of days between fertilization events and fertilization will not occur until the minimum number of days has been met. Because IFA will also affect manual fertilization, set IFA = 0 if manual fertilization is used (BFT0 = 0)./ *(Range: 0 to 365)*
L6 – F4	`IFD`	Furrow Dike Code *(cols. 13-16)* Furrow dikes (or tied ridges) are small dams constructed, usually by tillage equipment, in the furrows. They are designed to impede runoff and promote infiltration of rainfall and/or sprinkler irrigation. EPIC simulates the construction, function, and destruction of furrow dikes. The furrow dike code IFD is used to determine whether dikes are simulated. Allowed values: 0 Furrow dike system not simulated 1 Furrow dike system simulated
L6 – F5	`IDR0`	Drainage code *(cols. 17-20)* Artificial drainage systems (tiles, perforated pipes, open ditch drains, etc.) are often installed to remove excess water from fields. Allowed values: 0 No drainage system >0 The drainage system is simulated. Enter depth to drainage system in mm *(Range: 0 to 2500)*

Line - Field	Variable name	Description
L6 – F6	IDF0	Commercial Nitrogen Fertilizer Used for Automatic Application *(cols. 21-24)* Enter the ID number of the fertilizer from lists provided in the (FERT___.DAT). If none is entered the model defaults to the fertilizer ID 21 which should be Elemental N in the fertilizer table. It is wise to set this number even if there are no current plans to use this function so that the selected fertilizer number matches the correct number in the fertilizer list which is being used.
L6 – F7	MNU	Auto manure application without trigger *(cols. 25-28)* A value greater than zero allows the application of manure (if the minimum interval between fertilization is met). *(Range: 0 to 365)*
L6 – F8	IMW	Minimum Interval between auto mowing *(cols. 29-32)* This refers to the minimum length of time (days) set between mowing when the Auto Mow function is used. The crop will be mowed at this interval given the crop height is greater than the cutting height set on the mower used in the operation. For the IMW to take effect, an automatic mower must be included in the operation schedule. *(Range: 0 to 365)*
L6 – F9	IDFP	Commercial Phosphorus Fertilizer Used for Automatic Application *(cols. 33-36)* Enter the ID number of the fertilizer from lists provided in the (FERT___.DAT). If none is entered model defaults to fertilizer ID 22 which should be Elemental P in the fertilizer table. It is wise to set this number even if there are no current plans to use this function so that the selected fertilizer number matches the correct number in the fertilizer list which is being used.

Table 4. Suggested values of Manning's "n" for various condition channel flow (Chow 1959).

Characteristics of Channel	*Value Chosen*	*Range*
A. Excavated or dredged		
1. Earth, straight and uniform	0.0250	0.016 – 0.033
2. Earth, winding and sluggish	0.0350	0.023 – 0.050
3. Not maintained, weeds and brush	0.0750	0.040 – 0.140
B. Natural Streams		
1. Few trees, stones, or brush	0.0500	0.025 – 0.065
2. Heavy timber and brush	0.1000	0.050 – 0.150

Table 5. Suggested values and possible ranges of Manning's "n" for various condition overland flow.

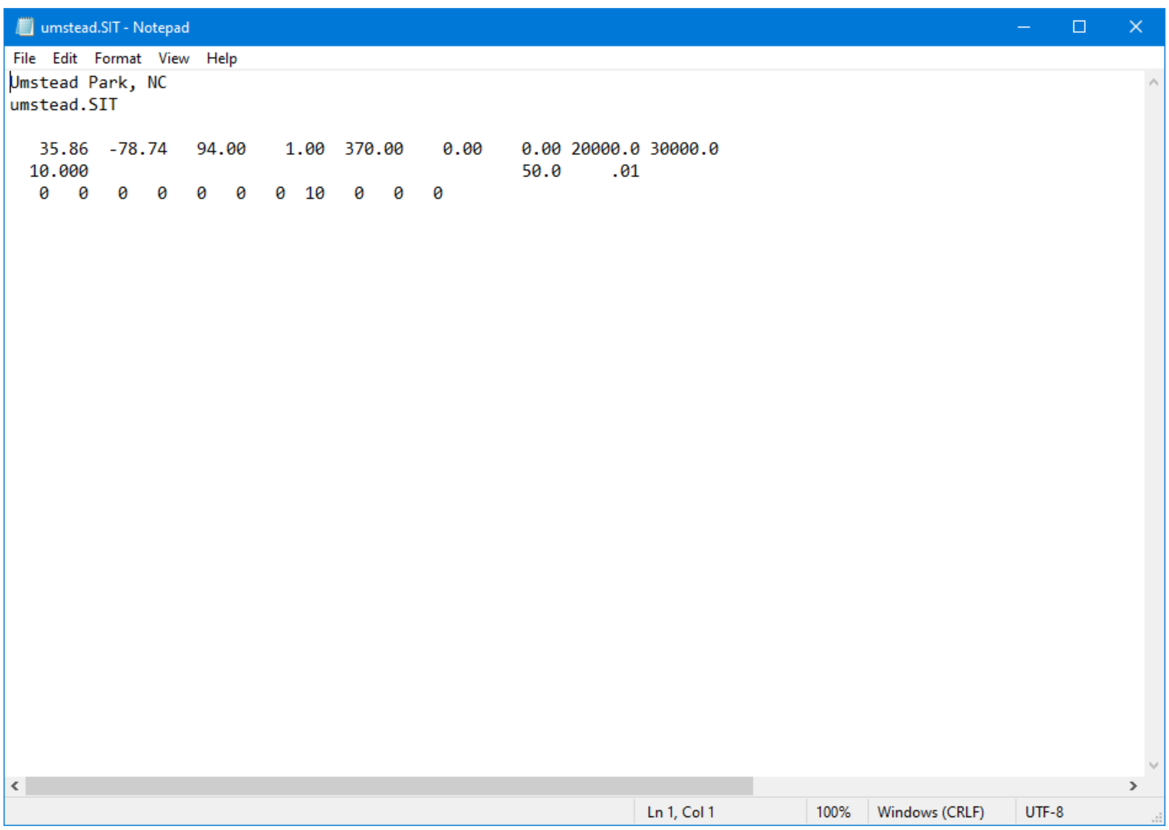
Type of Surface	*Value Chosen*	*Range*
Fallow, no residue	0.01	0.008 – 0.012
Conventional tillage, no residue	0.09	0.060 – 0.120
Conventional tillage, residue	0.19	0.160 – 0.220
Chisel plow, no residue	0.09	0.060 – 0.120
Chisel plow, residue	0.13	0.100 – 0.160
Fall disking, residue	0.40	0.300 – 0.500
No till, no residue	0.07	0.040 – 0.100
No till, with residue (0.5 – 1.0 Mg/ha)	0.12	0.070 – 0.170
No till, with residue (2.0 – 9.0 Mg/ha)	0.30	0.170 – 0.470
Rangeland (20% cover)	0.60	-
Short grass prairie	0.15	0.100 – 0.200
Dense grass	0.24	0.170 – 0.300
Bermudagrass	0.41	0.300 – 0.480

Table 6. P values and slope length limits for contouring.

Land slope (%)	P value	Maximum length (feet)
1 to 2	0.60	400
3 to 4	0.50	300
6 to 8	0.50	200
9 to 12	0.60	120
13 to 16	0.70	80
17 to 20	0.80	60
21 to 25	0.90	50

NOTE: Maximum length may be increased by 25% if residue cover after crop seeding will regularly exceed 50%.

Figure 5. Example of a site file used in EPIC1102.




```
Umstead Park, NC
umstead.SIT

   35.86  -78.74   94.00    1.00  370.00    0.00    0.00 20000.0 30000.0
  10.000                                            50.0      .01
   0   0   0   0   0   0   0  10   0   0   0
```

EPIC soil list file (SOILCOM.DAT)

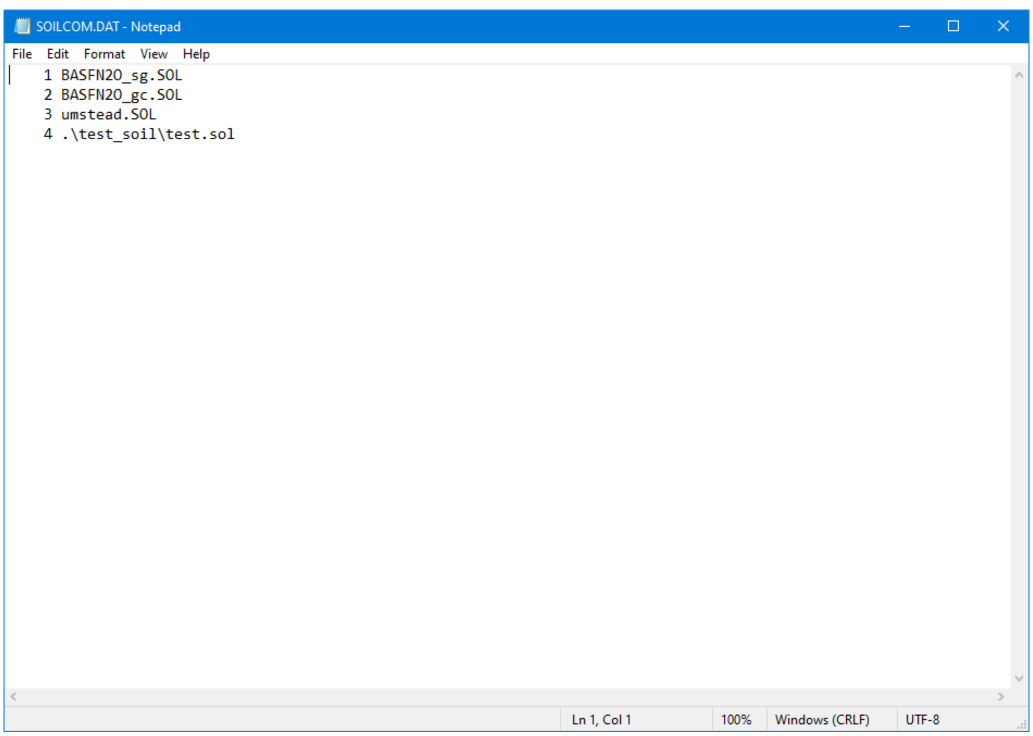
File format: space delimited.

The EPIC soil list is a listing of all soil files which have been previously created (see next section for details on how to create a soil file) and are available for use in creating runs. The soil list consists of a numbered listing of all soil files which can be referenced by number in the EPICRUN.DAT file. The name of the soil list file may be user defined; however, it must be properly identified in the EPICFILE.DAT file.

Table 7. Variables included in the EPIC soil list file.

Soil ID #	Site file name
Unique number to identify the soil file. This number is used in EPICRUN.DAT file to select the soil file used in each simulation.	Name of the soil file (including the extension of the file) or path + name of the soil file (including the extension). When using the name of the soil file, the soil file must be in the same folder as the EPIC executable. When using the path + file name, no spaces can be included in the path.

Figure 6. Example of EPIC soil list file. In this example, the soil files BASFN2O_sg.SOL, BASFN2O_gc.SOL, and Umstead.SOL are in the same directory of the EPIC executable while the soil file "test.sol" is in the folder "test_soil" which is located in the same folder where the EPIC executable is.



EPIC soil file (*filename*.SOL)

File format: different formats are used to read the EPIC soil file.

Line 1: space delimited, 2 fields (string)

Line 2 – 3: fixed format; 10 fields of 8 characters each (floating with 2 decimal digits) per line

Line 4 – 47: fixed format; 15 fields of 8 characters each (floating with 2 decimal digits) per line

Data for each soil is maintained in a separate soil file named *filename*.SOL. This file must be listed in the EPIC soil list file SOIL___.DAT (or user-defined name) with a unique reference number, which corresponds to the variable INPS in the run file EPICRUN.DAT. Elements included in the EPIC soil file are listed below.

Soil file – Line 1

Line – Field	Variable name	Description
L1 – F1	SOLS	Soil series name
L1 – F2	SOLO	Soil order This information can be used to drive the estimation of soil carbon losses if soil horizon is B or C, and if SOLO is one of the following: • Alfisols • Mollisols • Ultisols

Soil file – Line 2

Line - Field	Variable name	Description
L2 – F1	SALB	Soil albedo *(cols. 1-8)* Ratio of the amount of solar radiation reflected by the soil to the amount incident upon it, often expressed as a fraction. The value for albedo should be reported when the soil is at or near field capacity. *(Range: 0 to 1).*

Line - Field	Variable name	Description
L2 – F2	HSG	Soil hydrologic group *(cols. 9-16)* The U.S. Natural Resource Conservation Service (NRCS) classifies soils into four hydrologic groups based on infiltration characteristics of the soils. NRCS Soil Survey Staff (1996) defines a hydrologic group as a group of soils having similar runoff potential under similar storm and cover conditions. Soil properties that influence runoff potential are those that impact the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to seasonally high-water table, saturated hydraulic conductivity, and depth to a very slowly permeable layer. The definitions for the different classes are: A Soils having high infiltration rates when thoroughly wetted, consisting chiefly of sand or gravel that are deep and well to excessively drained. These soils have high rate of water transmission (low runoff potential) B Soils having moderate infiltration rates when thoroughly wetted, chiefly moderately deep to deep, moderately well to well drained, with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. C Soils having slow infiltration rates when thoroughly wetted, chiefly with a layer that impedes the downward movement of water or of moderately fine to fine texture and a slow infiltration rate. These soils have a slow rate of water transmission (high runoff potential). D Soils having very slow infiltration rates when thoroughly wetted, chiefly clay soils with a high swelling potential; soils with a high permanent water table; soils with a clay pan or clay layer at or near the surface; and shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission. See Table 8 below for hydrologic group rating criteria. Accepted values are 1 for hydrologic group A 2 for hydrologic group B 3 for hydrologic group C 4 for hydrologic group D
L2 – F3	FFC	Initial soil water content *(cols. 17-24)* Soil water content at the beginning of the simulation as a fraction of field capacity. Set at zero if unknown. *(Range: 0 to 1)*

Line - Field	Variable name	Description
L2 – F4	`WTMN`	Minimum depth to water table *(cols. 25-32)* This is the depth in meters from the soil surface to the water table when the water table is at its highest level. With the depth set at zero, the model automatically sets the depth deep enough to remove any effects (default at 50 m). Fluctuation of water table is simulated as a function of groundwater storage. Set to 0 if unknown. *(Range: 0 to 100 meters)*
L2 – F5	`WTMX`	Maximum depth to water table *(cols. 33-40)* This is the depth in meters from the soil surface to the water table when the water table is at its lowest level. Set to 0 if unknown. *(Range: 0 to 100 meters)*
L2 – F6	`WTBL`	Initial water table height *(cols. 41-48)* This is the depth in meters from the soil surface to the current water level at which the model will begin the simulation. Throughout the simulation the water level will fluctuate up and down between WTMN and WTMX. This depth must be greater than or equal to WTMN and less than or equal to WTMX. Set to 0 if unknown. WTMN, WTMX, and WTBL are very important when the field contains a water table that is near the surface. Default settings assume the water table is deep enough not to affect plant growth; however, if the water table is within several feet of the surface, it can provide an extra supply of water that ordinarily would not be accounted for in the model. *(Range: 0 to 100 meters)*
L2 – F7	`GWST`	Groundwater storage *(cols. 49-56)* The amount of groundwater storage in millimeters available at the beginning of the simulation. Set to 0 if unknown. *(Range: 0 to 200 mm)*

Line - Field	Variable name	Description
L2 – F8	`GWMX`	Maximum groundwater storage *(cols. 57-64)* The maximum amount of groundwater storage available in millimeters. Set to 0 if unknown. *(Range: 10 to 500 mm)*
L2 – F9	`RFT0`	Groundwater residence time *(cols: 65-72)* The length of time water spends in the groundwater portion of the hydrologic cycle in days. Set to zero if unknown. *(Range: 1 to 365 days)*
L2 – F10	`RFPK`	Ratio between return flow and return flow + deep percolation *(cols. 73-80)* Set to 0 if unknown. *(Range: 0.01 to 0.99)*

Table 8. Hydrologic Grouping Criteria.

Criteria*	Hydrologic Soil Groups			
	A	B	C	D
Final constant infiltration rate (mm hr^{-1})	7.6-11.4	3.8-7.6	1.3-3.8	0-1.3
Mean permeability: surface layer (mm hr^{-1})	> 254.0	84.0-254.0	8.4-84.0	< 8.4
Mean permeability: most restrictive layer below the surface layer to a depth of 1.0 m (mm hr^{-1})	> 254.0	84.0-254.0	8.4-84.0	< 8.4
Shrink-swell potential: most restrictive layer**	Low	Low	Moderate	High, Very High
Depth to bedrock or cemented pan (mm)	> 1016	> 508	> 508	< 508
DUAL HYDROLOGIC GROUPS	A/D	B/D	C/D	
Mean depth to water table (m)	< 0.61	< 0.61	< 0.61	

* These criteria are guidelines only. They are based on the theory that the minimum permeability occurs within the uppermost 50 cm. If the minimum permeability occurs between a depth of 50 to 100 cm, then the Hydrologic Soil Group is increased one group. For example, C to B. If the minimum permeability occurs below a depth of 100 cm, the Hydrologic Soil Group is based on the permeability above 100 cm, using the rules previously given.

** Shrink-swell potential is assigned to a profile using the following guidelines:

Low: All soils with sand, loamy sand, sandy loam, loam or silt loam horizons that are at least 50 cm thick from the surface without a clay horizon within 100 cm of the surface.

Medium: All soils with clay loam horizons within 50 cm of the surface or soils with clay horizons from 50 to 100 cm beneath the surface.

High: All soils with clay horizons within 50 cm of the surface. Lower the shrink-swell potential one class when kaolinite clay is dominant.

Soil file – Line 3

Line - Field	Variable name	Description
L3 – F1	TSLA	Number of soil layers after splitting *(cols. 1-8)* It sets the number of soil layers created by the model when splitting the original soil layers. No splitting occurs if TSLA is set to zero. *(Range: 3 to 15).*

Line - Field	Variable name	Description
L3 – F2	XIDP	Soil weathering code *(cols. 9-16)* The soil weathering code is used to provide information for estimating the phosphorus sorption ratio. If no weathering information is available or if the soil contains $CaCO_3$, XIDP is left at 0. Accepted values are: 0 for calcareous and non-calcareous soils without weathering information 1 for non $CaCO_3$ slightly weathered 2 for non $CaCO_3$ moderately weathered 3 for non $CaCO_3$ highly weathered 4 Input Phosphorus sorption ratio (PSP) or active + stable mineral P (kg/ha)
L3 – F3	RTN0	Number of years of cultivation when simulation begins *(cols. 17-24)* This parameter affects the partitioning of nitrogen and carbon into the passive and slow humus pools. The number of years of cultivation before the simulation starts is used to estimate the fraction of the organic N pool that is mineralizable. Mineralization is more rapid from soil recently in sod. Also, increasing the number of years the field has been in cultivation increases the amount of C and N in the passive pool. This means it will take longer for the carbon and nitrogen to become available. *(Range: 0 to 300 years)*
L3 – F4	XIDK	Soil grouping *(cols. 25-32)* Accepted values are: 1 = Kaolinitic soil group 2 = Mixed soil group 3 = Smectitic soil group
L3 – F5	ZQT	Minimum thickness of maximum layer in meters *(cols. 33-40)* The model splits layers with thickness greater than ZQT. This splitting scheme produces thinner layers near the soil surface throughout the simulation period. Since most activity (tillage, root growth, microbial activity, rainfall/runoff interaction, etc.) occurs relatively near the soil surface, concentrating computational effort in that zone by using thin layers is very desirable. As soil layers are eroded and lost from the system, layer splitting continues until the number of layers equals TSLA. When the thickest soil layer reaches ZQT, no further splitting occurs. Instead, the number of soil layers is reduced until only

Line - Field	Variable name	Description
L3 – F5 (cont.)	ZQT (cont.)	two layers remain. At that time, the simulation stops. The simulation will also stop if the user-specified, minimum soil-profile thickness (ZF) is reached. If ZQT and ZF are not inputted, the model sets both of them to 0.1 m. Refer to TSLA, ZF and ZTK for further information. Set to 0 if unknown. *(Range: 0.01 to 0.25 meters)*
L3 – F6	ZF	Minimum profile thickness *(cols. 41-48)* This is the minimum thickness (in meters) of the profile that is allowed. If the profile is eroded to this thickness, the simulation will stop. If ZF is not inputted, the model sets it to 0.1 m. Refer to TSLA, ZQT, and ZTK for further information. *(Range: 0.05 to 0.25 meters)*
L3 – F7	ZTK	Minimum layer thickness for beginning simulation layer *(cols. 49-56)* The model splits the first layer with thickness greater than ZTK (in meters); if none exists the thickest layer is split. This is only done once to make certain there are no extremely thick layers even at lower depths. Refer to TSLA, ZQT and ZF for further information. *(Range: 0.05 to 0.25 mm)*
L3 – F8	FBM	Fraction of organic carbon in biomass pool *(cols. 57-64)* Set to 0 if unknown and the model will assign the default value of 0.04. *(Range: 0.03 to 0.05)*
L3 – F9	FHP	Fraction of carbon in passive pool *(cols. 65-72)* Set to 0 if unknown and the model will calculate its value as a function of RTN0. *(Range: 0.3 to 0.7)*
L3 – F10	XCC	NOT USER INPUT *(cols. 73-80)* This is a code written automatically by the model when a .SOT file is created. XCC is equal to 0 for regular soil files. XCC is equal to 1 for model generated SOT files.

Soil file – Line number > 3

Starting from line 4, rows are assigned to variables while columns are assigned to soil layers. Up to 15 soil layers can be input. As reported at the beginning of this section, the format used from line 4 on is fixed with 15 fields of 8 characters each (floating with 2 decimal digits) per line.

Line number	Variable	Description
4	Z	Depth to bottom of layer Depth from the soil surface to the bottom of the layer (meters) *(Range: 0.01 to 10.0)*
5	BD	Moist bulk density (Mg m^{-3}) The soil bulk density represents the ratio of the mass of solid particles to the total volume of the soil. Usually, BD values fall between 1.1 and 1.9 Mg m^{-3}. *(Range: 0.5 to 2.5)*
6	U	Soil water content at wilting point (fraction) The wilting point is the soil water content at 1500 KPa or -15 Bars. The value of U must be lower than the value of FC. Set to 0 if unknown. *(Range: 0.01 to 0.5)*
7	FC	Soil water content at field capacity (fraction) The field capacity is the soil water content at 33 KPa or -0.33 bar. The value of FC must be greater than U and cannot be greater than 1. *(Range: 0.1 to 0.9)*
8	SAN	Sand content (%) Fraction of soil particles which have a diameter between 2.0 and 0.05 mm. *(Range: 1 to 99)*
9	SIL	Silt content (%) Fraction of soil particles which have a diameter between 0.05 and 0.002 mm. *(Range: 1 to 99)*

Line number	Variable	Description
10	WON	Initial organic nitrogen concentration (g N Mg^{-1} or ppm) Users may define the concentration of organic nitrogen (dry weight basis) contained in humic substances for all soil layers at the beginning of the simulation. If the user does not specify initial nitrogen concentrations, EPIC will initialize levels of organic nitrogen. Set to 0 if unknown. *(Range: 100 to 5000)*
11	PH	Soil pH It is the pH of a solution in equilibrium with the soil. It is determined by means of a glass, quinhydrone, or other suitable electrode or indicator at a specified soil-solution ratio in a specified solution, usually distilled water, 0.01 M $CaCl_2$ or 1 M KCl. *(Range: 3 to 9)*
12	SMB	Sum of bases (cmol kg^{-1}) The sum of bases (Ca^{++}, K^{+}, etc.) on the cation exchange complex. Set to 0 if unknown. *(Range: 0 to 150)*
13	WOC	Organic carbon concentration (%) It is the concentration of organic carbon present in the soil. Set to 0 if unknown. *(Range: 0.1 to 10)*
14	CAC	Calcium carbonate content (%) It is the carbon carbonate content of the soil. A compound, $CaCO_3$ is found in nature as calcite and argonite and in plant ashes, bones, and shells. $CaCO_3$ is found in calcareous soils. It is also used as a liming agent to increase the pH of a soil. Set to 0 if unknown. *(Range: 0 to 99)*

Line number	Variable	Description
15	CEC	Cation exchange capacity (cmol kg^{-1}) The cation exchange capacity of a soil is the quantity of positive ions necessary to neutralize the negative charge of a unit quantity of soil, under a given set of conditions. Set to 0 if unknown. *(Range: 0 to 150)*
16	ROK	Coarse fragment content (%) The percent (in volume) of the sample which has a particle diameter > 2 mm, i.e. the percent of the sample which does not pass through a 2 mm sieve. Set to 0 if unknown. *(Range: 0 to 99)*
17	CNDS	Initial soluble nitrogen concentration (g Mg^{-1}) Users may define the concentration of nitrate (dry weight basis) for all soil layers at the beginning of the simulation. Set to 0 if unknown. *(Range: 0.01 to 500)*
18	PKRZ	Initial soluble phosphorus concentration (g Mg^{-1}) Users may define the concentration of solution P (dry weight basis) for all soil layers at the beginning of the simulation. Set to 0 if unknown. *(Range: 0 to 20)*
19	RSD	Crop residue (Mg ha^{-1}) The amount of biomass in each soil layer at the beginning of the simulation. Set to 0 if unknown. *(Range: 0 to 20)*

Line number	Variable	Description
20	BDD	Dry bulk density (Mg m^{-3}) Density of the soil after oven drying. Set to 0 if unknown (BD value will be assigned to BDD). *(Range: 0 to 2.0)*
21	PSP	Phosphorus sorption ratio (fraction) The fraction of phosphorus adsorbed on soil particle surfaces Set to 0 if unknown. The model will estimate PSP according to the soil weathering code (XIDP) and using CAC, PKRZ, BSA, PH, and/or CLA depending on XIDP. *(Range: 0 to 0.9)*
22	SATC	Saturated conductivity (mm h^{-1}) Rate at which water passes through the soil layer, when saturated. The saturated hydraulic conductivity relates soil water flow rate (flux density) to the hydraulic gradient and is a measure of the ease of water movement through the soil. The saturated conductivity is the reciprocal of the resistance of the soil matrix to water flow. Set to 0 if unknown. *(Range: 0.00001 to 100)*
23	HCL	Lateral hydraulic conductivity (mm h^{-1}) Set to 0 if unknown. *(Range: 0.00001 to 10)*
24	WP	Initial organic phosphorus concentration (g Mg^{-1}) Users may define the concentration of organic phosphorus (dry weight basis) contained in humic substances for all soil layers at the beginning of the simulation. Set to 0 if unknown. *(Range: 50 to 1000)*

Line number	Variable	Description
25	EXCK	Exchangeable potassium concentration (g Mg^{-1}) The amount of potassium on the surface of soil particles that can be readily replaced with a salt solution. Set to 0 if unknown. *(Range: 0 to 200)*
26	ECND	Electrical conductivity (mmho cm^{-1}) Conductivity of electricity through water or an extract of soil. Commonly used to estimate the soluble salt content in solution. For a conversion to commonly used units, 1 mmho cm^{-1} is equal to 1 dS m^{-1}. Set to 0 if unknown. *(Range: 0 to 50)*
27	STFR	Fraction of water storage interacting with nitrogen leaching It is the fraction of soil porosity that interacts with percolating water as nitrogen leaching occurs. Set to 0 if unknown. *(Range: 0.05 to 1.0)*
28	ST	Initial soil water storage (fraction, m/m) Fraction of field capacity initially available at the start of the simulation. Set to 0 if unknown (the value of FC will be used) *(Range: 0.001 to 1.0)*
29	CPRV	Fraction inflow partitioned to vertical crack or pipe flow NOT USED It is the fraction of water flowing through the soil profile partitioned to flow in vertical cracks or pipes. Set to 0 if unknown. *(Range: 0.0 to 0.05)*
30	CPRH	Fraction inflow partitioned to horizontal crack or pipe flow NOT USED It is the fraction of water flowing through the soil profile partitioned to flow in horizontal cracks or pipes. Set to 0 if unknown. *(Range: 0.0 to 0.05)*

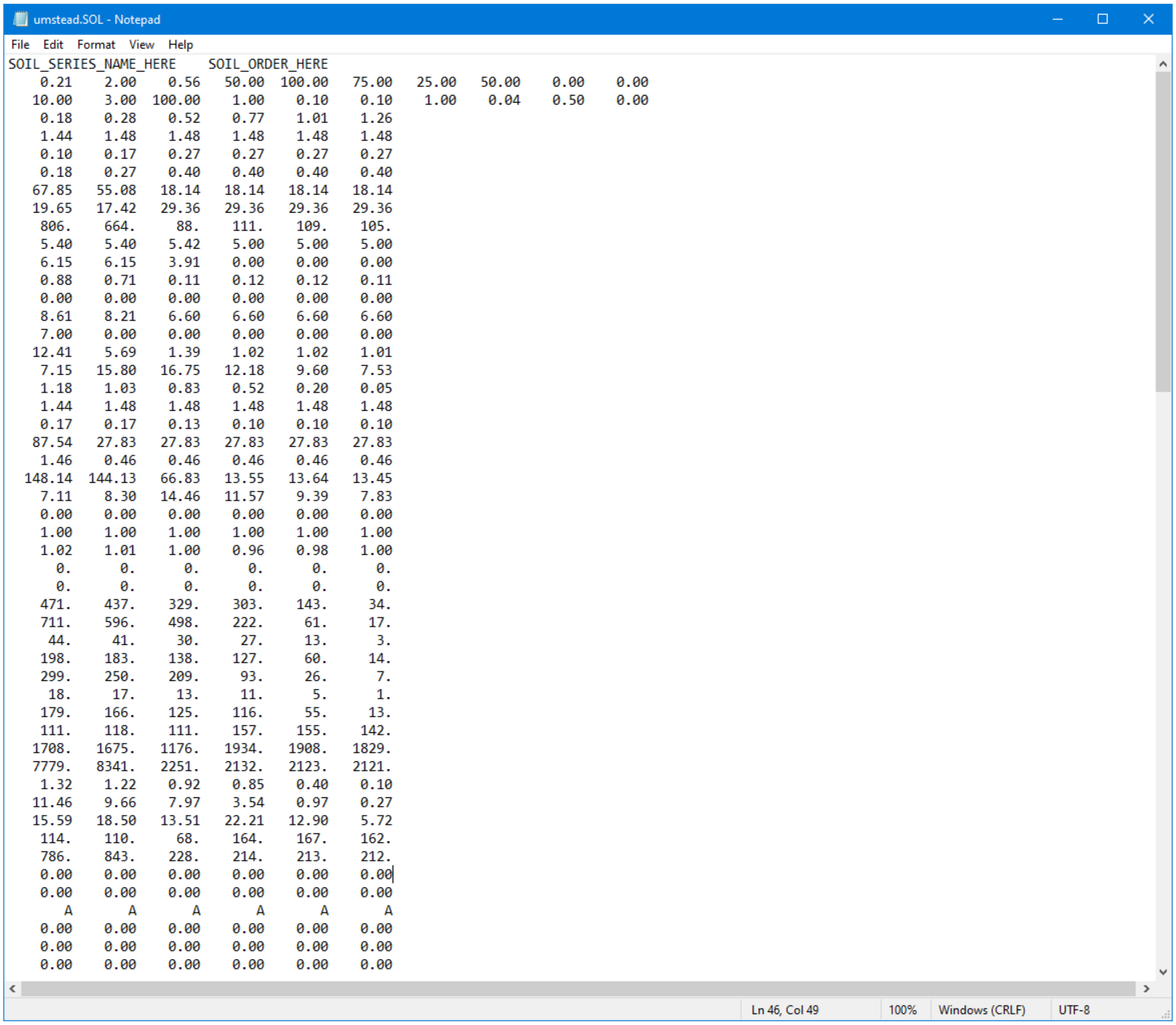
Line number	Variable	Description
31	`WLS`	Structural litter (kg ha^{-1}) One of the two litter components that contains all the lignin from plant residues and roots. The structural litter component has a fixed C/N ratio. Set to 0 if unknown. *(Range: 0.0 to 10000)*
32	`WLM`	Metabolic litter (kg ha^{-1}) One of the two litter components is made up of readily decomposable and water-soluble organic matter. Set to 0 if unknown. *(Range: 0.0 to 10000)*
33	`WLSL`	Lignin content of structural litter (kg ha^{-1}) Lignin is a complex polymer that binds to cellulose fibers and gives strength to the cell walls of plants. It is very resistant to decomposition. Set to 0 if unknown. *(Range: 0.0 to 10000)*
34	`WLSC`	Carbon content of structural litter (kg ha^{-1}) Carbon makes up almost half of the elemental composition of the dry matter in plants and is a common constituent of all organic matter. It is also present in the atmosphere in the form of CO_2. Set to 0 if unknown. *(Range: 0.0 to 10000)*
35	`WLMC`	Carbon content of metabolic litter (kg ha^{-1}) See WLSC and WLM for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*

Line number	Variable	Description
36	`WLSLC`	Carbon content of lignin of structural litter (kg ha^{-1}) See WLSC, WLSL and WLS for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*
37	`WLSLNC`	Nitrogen content of lignin of structural litter (kg ha^{-1}) The amount of nitrogen found in the lignin portion of the structural litter. See WLSL and WLS for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*
38	`WBMC`	Carbon content of biomass organic pool (kg ha^{-1}) The carbon content of the fresh soil organic matter. Set to 0 if unknown. *(Range: 0.0 to 10000)*
39	`WHSC`	Carbon content of slow humus pool (kg ha^{-1}) Slow humus is a conceptual component of soil organic matter that decomposes at rates intermediate between the microbial and passive humus components. Set to 0 if unknown. *(Range: 0.0 to 10000)*
40	`WHPC`	Carbon content of passive humus pool (kg ha^{-1}) Passive humus is a conceptual component composed of old or stable soil organic matter. Set to 0 if unknown. *(Range: 0.0 to 10000)*
41	`WLSN`	Nitrogen content of structural litter (kg ha^{-1}) See WLS for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*

Line number	Variable	Description
42	WLMN	Nitrogen content of metabolic litter (kg ha^{-1}) See WLM for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*
43	WBMN	Nitrogen content of biomass pool (kg ha^{-1}) The nitrogen content of the fresh soil organic matter. Set to 0 if unknown. *(Range: 0.0 to 10000)*
44	WHSN	Carbon content of slow humus pool (kg ha^{-1}) See WHSC for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*
45	WHPN	Carbon content of passive humus pool (kg ha^{-1}) See WHPC for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*
46	FE26	Iron content (%) It can be used in the estimation of carbon losses if the soil order (SOLO) is Ultisols and if soil horizon (ASHZ) is B or C. Set to 0 if unknown. *(Range: 0.1 to 50.0)*
47	SULF	Sulfur content (%) Set to 0 if unknown. *(Range: 0.01 to 0.06)*
48	ASHZ	Soil horizon The format for this variable is a string with 8 characters (e.g., •••••••A – seven spaces and one letter).

Line number	Variable	Description
48 (cont.)	**ASHZ** (cont.)	Accepted values are • A • B • C This information drives the estimation of soil carbon losses. If ASHZ is equal to B or C, the approach used in the estimation is driven by the soil order (SOLO). Set to A if unknown.
49	**CGO2**	O_2 concentration in gas phase (g m^{-3} of soil air) This information is used when the new O2 ratio method is selected for the oxygen-depth function (IOX = 2 in the EPIC control file) or when the Izaurralde denitrification approach is selected (IDN > 2 in the EPIC control file). Set to 0 if unknown. *(Range: 110 to 275)* for more information see (R. C. Izaurralde et al., 2017)
50	**CGCO2**	CO_2 concentration in gas phase (g m^{-3} of soil air) This information is used when the Izaurralde denitrification approach is selected (IDN > 2 in the EPIC control file). Set to 0 if unknown. *(Range: 0.2 to 1.2)* for more information see (R. C. Izaurralde et al., 2017)
51	**CGN2O**	N_2O concentration in gas phase (g m^{-3} of soil air) This information is used when the Izaurralde denitrification approach is selected (IDN > 2 in the EPIC control file). Set to 0 if unknown. *(Range: 0.004 to 0.01)* for more information see (R. C. Izaurralde et al., 2017)

Figure 7. Example of a soil file used in EPIC1102.



umstead.SOL - Notepad

File Edit Format View Help

```
SOIL_SERIES_NAME_HERE     SOIL_ORDER_HERE
    0.21     2.00     0.56    50.00   100.00    75.00    25.00    50.00     0.00     0.00
   10.00     3.00   100.00     1.00     0.10     0.10     1.00     0.04     0.50     0.00
    0.18     0.28     0.52     0.77     1.01     1.26
    1.44     1.48     1.48     1.48     1.48     1.48
    0.10     0.17     0.27     0.27     0.27     0.27
    0.18     0.27     0.40     0.40     0.40     0.40
   67.85    55.08    18.14    18.14    18.14    18.14
   19.65    17.42    29.36    29.36    29.36    29.36
    806.     664.      88.     111.     109.     105.
    5.40     5.40     5.42     5.00     5.00     5.00
    6.15     6.15     3.91     0.00     0.00     0.00
    0.88     0.71     0.11     0.12     0.12     0.11
    0.00     0.00     0.00     0.00     0.00     0.00
    8.61     8.21     6.60     6.60     6.60     6.60
    7.00     0.00     0.00     0.00     0.00     0.00
   12.41     5.69     1.39     1.02     1.02     1.01
    7.15    15.80    16.75    12.18     9.60     7.53
    1.18     1.03     0.83     0.52     0.20     0.05
    1.44     1.48     1.48     1.48     1.48     1.48
    0.17     0.17     0.13     0.10     0.10     0.10
   87.54    27.83    27.83    27.83    27.83    27.83
    1.46     0.46     0.46     0.46     0.46     0.46
  148.14   144.13    66.83    13.55    13.64    13.45
    7.11     8.30    14.46    11.57     9.39     7.83
    0.00     0.00     0.00     0.00     0.00     0.00
    1.00     1.00     1.00     1.00     1.00     1.00
    1.02     1.01     1.00     0.96     0.98     1.00
      0.       0.       0.       0.       0.       0.
      0.       0.       0.       0.       0.       0.
    471.     437.     329.     303.     143.      34.
    711.     596.     498.     222.      61.      17.
     44.      41.      30.      27.      13.       3.
    198.     183.     138.     127.      60.      14.
    299.     250.     209.      93.      26.       7.
     18.      17.      13.      11.       5.       1.
    179.     166.     125.     116.      55.      13.
    111.     118.     111.     157.     155.     142.
   1708.    1675.    1176.    1934.    1908.    1829.
   7779.    8341.    2251.    2132.    2123.    2121.
    1.32     1.22     0.92     0.85     0.40     0.10
   11.46     9.66     7.97     3.54     0.97     0.27
   15.59    18.50    13.51    22.21    12.90     5.72
    114.     110.      68.     164.     167.     162.
    786.     843.     228.     214.     213.     212.
    0.00     0.00     0.00     0.00     0.00     0.00
    0.00     0.00     0.00     0.00     0.00     0.00
       A        A        A        A        A        A
    0.00     0.00     0.00     0.00     0.00     0.00
    0.00     0.00     0.00     0.00     0.00     0.00
    0.00     0.00     0.00     0.00     0.00     0.00
```

Ln 46, Col 49 100% Windows (CRLF) UTF-8

EPIC management list file (OPSCCOM.DAT)

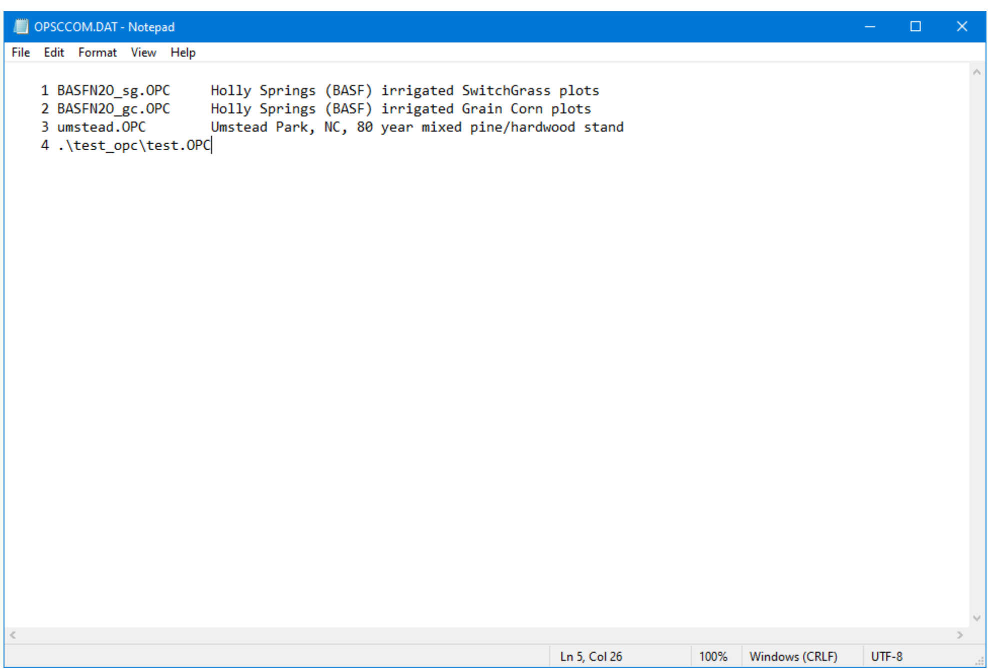
File format: space delimited.

The EPIC management list is a listing of all management files which have been previously created (see next section for details on how to create a management file) and are available for use in creating runs. The management list consists of a numbered listing of all management files which can be referenced by number in the EPICRUN.DAT file. The name of the management list file may be user defined; however, it must be properly identified in the EPICFILE.DAT file.

Table 9. Variables included in the EPIC management list file.

Management ID #	Management file name
Unique number to identify the management file. This number is used in EPICRUN.DAT file to select the management file used in each simulation.	Name of the management file (including the extension of the file) or path + name of the management file (including the extension). When using the name of the management file, the management file must be in the same folder of the EPIC executable. When using the path + file name, no spaces can be included in the path.

Figure 8. Example of EPIC management list file. In this example, the management files BASFN2O_sg.OPC, BASFN2O_gc.OPC, and Umstead.OPC are in the same directory of the EPIC executable while the management file "test.OPC" is in the folder "test_opc" which is located in the folder where the EPIC executable is. A description of the management can be included in the management list after the name of the management file.



EPIC management file (*filename*.OPC or *filename*.OPS)

File format: different formats are used to read the EPIC management file.

Line 1: Free format

Line 2: fixed format; up to 20 fields of 8 characters each (integers)

Line 3 – n: fixed format; 3 fields of 3 characters each (integers), 4 fields of 5 characters each (integers), and 10 fields of 8 characters each (floating) per line

Data for each management is maintained in a separate management file named *filename*.OPC or *filename*.OPS. This file must be listed in the EPIC management list file OPSC___.DAT (or user-defined name) with a unique reference number, which corresponds to the variable IOPS in the run file EPICRUN.DAT. Elements included in the EPIC management file are listed below.

Management file – Line 1

Line - Field	Variable name	Description
L1 – F1		Short description of the management represented in the management file.

Management file – Line 2

Line - Field	Variable name	Description
L2 – F1	LUN	Land Use Number *(cols. 1-4)* This is the land use number from the NRCS Land Use-Hydrology soil group table below (Table 10). Refer to the column labeled Land Use Number in the table below. This number along with the hydrologic soil group is used to determine the curve number. *(Range: 1 to 35)*
L2 – F2	IAUI	Implement for auto irrigation *(cols. 5-8)* Select the implement used for automatic irrigation. The number refers to the implement/tillage table TILL___.DAT. If set to zero, the model will assign the default value of 500 and implement with ID number 500 in the TILL___.DAT will be used to apply automatic irrigation (center pivot by default).

Table 10. Runoff curve number for hydrologic soil-cover complexes.

Land use	Cover treatment or practice	Hydrologic condition	Hydrologic soil group A	B	C	D	Land Use Number
Fallow	Straight row	---	77	86	91	94	1
Row crops	Straight row	Poor	72	81	88	91	2
		Good	67	78	85	89	3
	Contoured	Poor	70	79	84	88	4
		Good	65	75	82	86	5
	Contoured and terraced	Poor	66	74	80	82	6
		Good	62	71	78	81	7
Small grain	Straight row	Poor	65	76	84	88	8
		Good	63	75	83	87	9
	Contoured	Poor	63	74	82	85	10
		Good	61	73	81	84	11
	Contoured and terraced	Poor	61	72	79	82	12
		Good	59	70	78	81	13
Close-seeded legumes[1] or rotation meadow	Straight row	Poor	66	77	85	89	14
		Good	58	72	81	85	15
	Contoured	Poor	64	75	83	85	16
		Good	55	69	78	83	17
	Contoured and terraced	Poor	63	73	80	83	18
		Good	51	67	76	80	19
Pasture or range	<50% ground cover or heavily grazed.	Poor	68	79	86	89	20
	50-75% ground cover and not heavily grazed.	Fair	49	69	79	84	21
	>75% ground cover and lightly grazed.	Good	39	61	74	80	22
	Above characteristics and contoured	Poor	47	67	81	88	23
		Fair	25	59	75	83	24
		Good	6	35	70	79	25
Meadow	Continuous grass, not grazed and generally mowed for hay	Good	30	58	71	78	26
Woods	Small trees and brush (heavy grazing and regular burning).	Poor	45	66	77	83	27
	Woods are grazed but not burned, some litter covers the soil.	Fair	36	60	73	79	28
	Woods are not grazed, litter and brush soil cover.	Good	25	55	70	77	29
Farmsteads		---	59	74	82	86	30
Roads	Dirt[2]	---	72	82	87	89	31
	Hard surface[2]	---	74	84	90	92	32
Sugarcane		---	39	61	74	80	33
Bermuda grass		---	49	69	79	84	34
Impervious	Pavement, urban areas	---	98	98	98	98	35

Table taken from the National Engineering Handbook (U.S. Department of Agriculture, Soil Conservation Service, 1972).

[1] Close-drilled or broadcast.

[2] Including right of way.

Management file – Line 3 to *n*

Starting from line 3, each row has different fields used to simulate tillage and management operations. The meaning of some fields can change depending on the operation simulated.

Line - Field	Variable name	Description
L3-n – F1	`JX(1)`	Year of operation *(cols. 1-3)* Year in the rotation when the operation occurs. 1 = operation occurs in 1st year of the rotation 2 = operation occurs in 2nd year of the rotation … Nth year *(Range: 1 to 100)*
L3-n – F2	`JX(2)`	Month of operation *(cols. 4-6)* Month of the year when the operation occurs. *(Range: 1 to 12)*
L3-n – F3	`JX(3)`	Day of operation *(cols. 7-9)* Day of the month when the operation occurs. *(Range: 1 to 31)*
L3-n – F4	`JX(4)`	Equipment ID number used for the operation *(cols. 10-14)* Refers to the ID number that is given to each tillage operation or piece of equipment in TILLCOM.DAT file. *(Range: 1 to 99999)*
L3-n – F5	`JX(5)`	Tractor ID number used for the operation *(cols. 15-19)* Refers to the ID number given to each tractor in the TILLCOM.DAT file. It is used for economic purposes only and can be set to zero if economic analysis is not needed. *(Range: 1 to 99999)*

Line - Field	Variable name	Description
L3-n – F6	`JX(6)`	Crop ID number *(cols. 20-24)* Refers to the crop ID number given to each crop listed in CROPCOM.DAT file. *(Range: 1 to 99999)*
L3-n – F7	`JX(7)`	Different meanings depending on the type of operation set with JX(4) *(cols. 25-29)* Time from planting to maturity – XMTU (number of years). THIS APPLIES TO PLANTING OPERATION OF TREES ONLY. This refers to the time to reach complete maturity of the tree (full life of the tree). No potential heat units are entered for trees. Time from planting to harvest – LYR (number of years). FOR THE HARVEST OPERATION OF TREES ONLY (portion of full maturity). Pesticide ID number. FOR PESTICIDE APPLICATIONS ONLY. Refers to the ID number given to each pesticide in the PESTCOM.DAT file. Fertilizer ID number. FOR FERTILIZER APPLICATIONS ONLY. Refer to the ID number given to each fertilizer in the FERTCOM.DAT file.
L3-n – F8	`OPV1`	Different meanings depending on the type of operation set with JX(4) *(cols. 30-37)* Potential heat units – PHU (°C). FOR PLANTING OPERATION ONLY. Total number of heat units (or growing degree days) needed to bring the plant from emergence to physiological maturity. Used in determining the growth curve. PHU is calculated using the base temperature of the crop. Application volume for irrigation (mm). FOR IRRIGATION OPERATION ONLY. It is the volume of water applied with the irrigation operation.

Line - Field	Variable name	Description

L3-n – F8
 	
(cont.)
	`OPV1`
	
	`(cont.)`
		Fertilizer application rate (kg ha^{-1})
		
		FOR FERTILIZATION ONLY. Amount of fertilizer applied with the fertilization. Set to zero for variable application rate (application rate will be estimated using PARM(28)).
		
		Pesticide application rate (g ha^{-1})
		
		FOR PESTICIDE APPLICATION ONLY. It is the amount of pesticide applied with the operation.
		
		Stocking rate for grazing (ha $head^{-1}$)
		
		FOR START GRAZING ONLY. It is the number of hectares available to each grazer.

L3-n – F9	`OPV2`	Different meanings depending on the type of operation set with JX(4) *(cols. 38-45)* Land use number – LUN. The land use number set previously will be overwritten if a positive value is provided here. Refer to Table 10 for allowed values of land use number. Curve number – CN. A value of the SCS runoff curve number can be directly assigned if a negative value is provided here. Use the SCS hydrologic soil group-curve number table for reference (Table 8). Pest control factor. FOR PESTICIDE APPLICATION ONLY. This is the fraction of pest population controlled by the pesticide application. It only applies to insects and diseases (not weeds). If the factor is set to 0.99, 99% of the pest will be killed by the pesticide.
L3-n – F10	`OPV3`	Automatic irrigation trigger *(cols. 46-53)* If OPV3 is ≠ 0, the automatic irrigation trigger set previously will be changed. Several options are offered: OPV3 = 0.0 The previous trigger remains active. OPV3 > 0 and < 1.0 Automatic irrigation based on plant water stress factor. The dimension (1 – BIR) equals the fraction of plant water stress

Line - Field	Variable name	Description
L3-n – F10 (cont.)	OPV3 (cont.)	allowed. Low values allow higher plant water stress before applying automatic irrigation. OPV3 = 1.0 Does not allow water stress. According to other rules set in the model, irrigation water is applied with the intent to eliminate water stress. OPV3 < 0.0 Plant available water deficit in root zone. Number is in mm and must be negative. OPV3 > 1.0 Soil water tension in top 200 mm of the soil profile. Absolute number is in kilopascals. OPV3 = -999.0 Sets water deficit high enough that only manual irrigations will occur. Effectively turns auto irrigation off.
L3-n – F11	OPV4	Runoff / irrigation ratio (vol./vol.) *(cols. 54-61)* It is the ratio between runoff volume and irrigation volume. Setting OPV4 greater than 0 will overwrite the value assigned to EFI in the EPIC control file (EPICCONT.DAT). The irrigation runoff ratio specifies the fraction of each irrigation application that is lost to runoff. Soluble nutrient loss through runoff applies. Changes in soil slope do not affect this amount dynamically.
L3-n – F12	OPV5	Plant population *(cols. 62-69)* FOR PLANTING OPERATION ONLY. Unit is plants m^{-2} or plants ha^{-1} if crop is a tree (in EPIC plant list file IHC = 7, 8, or 10). EPIC does not simulate tillering. In crops such as wheat and sugarcane which produce higher numbers of yielding tillers compared to the number of seeds or shoots planted, the plant population must be estimated based on the final yield producing tiller number.
L3-n – F13	OPV6	Max annual nitrogen fertilizer applied to a crop (kg ha^{-1}) *(cols. 70-77)* FOR PLANTING OPERATION ONLY. If OPV6 is set > 0, its value replaces the value of FMX set in the EPICCONT.DAT. FMX set a limit on the amount of fertilizer that could be applied on an annual basis regardless of the number of crops grown within a year. This is especially important when automatically applying fertilizer.

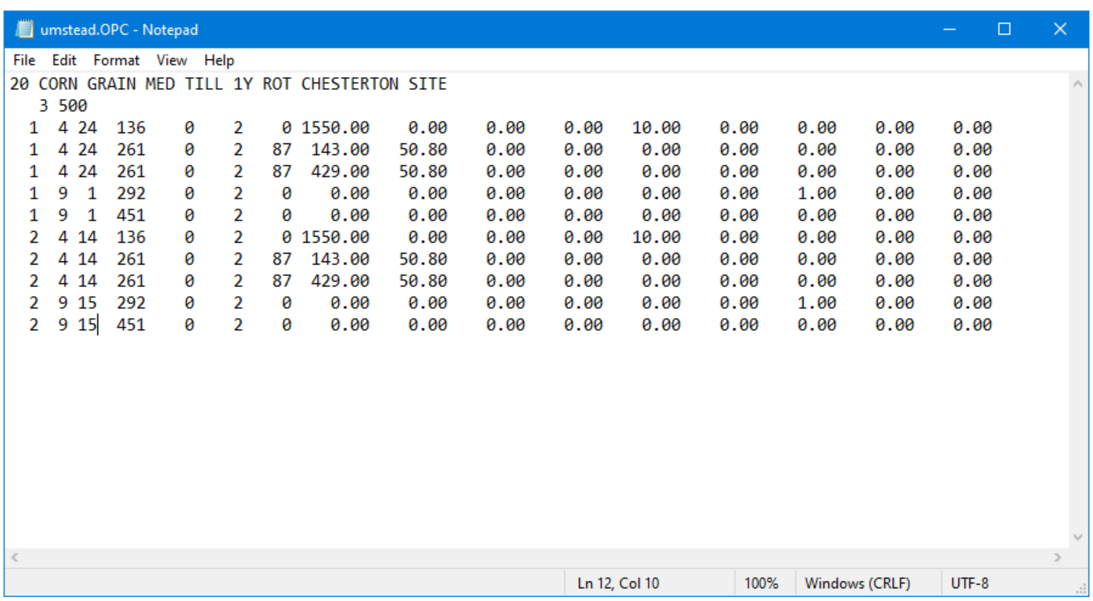
Line - Field	Variable name	Description
L3-n – F14	OPV7	Time of operation as fraction of growing season *(cols. 78-85)* This is also referred to as heat unit scheduling. Heat unit scheduling can be used to schedule operations at a particular stage of growth. For example, irrigation could be scheduled at 0.25, 0.5, and 0.75 which might represent different stages of crop growth. In this case, irrigation would be applied at 25%, 50%, and 75% of the potential heat units set at planting. When setting up an operation using heat unit scheduling it is best to enter earliest possible month and day (JX2 and JX3) that the operation could occur on because, for the operation to occur, the date of the operation as well as the number of heat units scheduled must be met. This is recommended because of the process followed by APEX: first the program checks if the date of the operation has been met; then it checks if the fraction of heat units has been met. See Table 11 for more details. Heat unit scheduling can also be used to adjust operations to the weather (temperatures) from year to year. If heat units are not scheduled (set to 0), operations will occur on the date set in the operation schedule and the operation will occur on the same date every year the crop is grown in the simulated rotation. Heat unit scheduling operations which occur from planting to harvest are based on the heat units set at planting. Operations which occur before planting are based on the total annual heat units which are calculated by the model. For some grain crops an in-field dry-down period is allowed. It is expressed as a fraction of the total heat units set at planting. In most cases the dry-down period is 10% to 15% of the total heat units. If a dry-down period is required, heat unit schedule the harvest operation to occur at 1.10, 1.15 or another appropriate fraction. In the case of forage harvesting, the forage is actually harvested well before the crop reaches full maturity. In this case heat unit schedule the forage harvest to 0.55 or another appropriate fraction.
L3-n – F15	OPV8	Minimum USLE C-Factor *(cols. 86-93)* It sets the minimum C factor value used in the estimation of soil erosion. If set to a value greater than zero, it will replace

Line - Field	Variable name	Description
L3-n – F15 (cont.)	OPV8 (cont.)	the value set with PARM(32) or any other previous value set with OPV8.
L3-n – F16	OPV9	Moisture content of grain requested for harvest *(cols. 94-101)* It sets the fraction of the grain moisture content to allow harvest operation. Harvest will occur only when the grain moisture content is lower than OPV9.

Table 11. Occurrence of operation based on date/heat unit.

Date	Heat units	Action
Date is met	Heat unit fraction has not been met	Operation will not occur until heat units have been met
Date is not met	Heat unit fraction is met	Operation will occur as soon as date is met. Note: excess GDUs will accumulate causing the operation to occur later in the growing cycle than expected
Date is met	Heat unit fraction is met	Operation will occur immediately

Figure 9. Example of a management file used in EPIC1102.




```
20 CORN GRAIN MED TILL 1Y ROT CHESTERTON SITE
   3 500
  1  4 24  136    0    2    0 1550.00    0.00    0.00    0.00   10.00    0.00    0.00    0.00    0.00
  1  4 24  261    0    2   87  143.00   50.80    0.00    0.00    0.00    0.00    0.00    0.00    0.00
  1  4 24  261    0    2   87  429.00   50.80    0.00    0.00    0.00    0.00    0.00    0.00    0.00
  1  9  1  292    0    2    0    0.00    0.00    0.00    0.00    0.00    0.00    1.00    0.00    0.00
  1  9  1  451    0    2    0    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
  2  4 14  136    0    2    0 1550.00    0.00    0.00    0.00   10.00    0.00    0.00    0.00    0.00
  2  4 14  261    0    2   87  143.00   50.80    0.00    0.00    0.00    0.00    0.00    0.00    0.00
  2  4 14  261    0    2   87  429.00   50.80    0.00    0.00    0.00    0.00    0.00    0.00    0.00
  2  9 15  292    0    2    0    0.00    0.00    0.00    0.00    0.00    0.00    1.00    0.00    0.00
  2  9 15  451    0    2    0    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
```

EPIC daily weather list file (WDLSTCOM.DAT)

File format: space delimited.

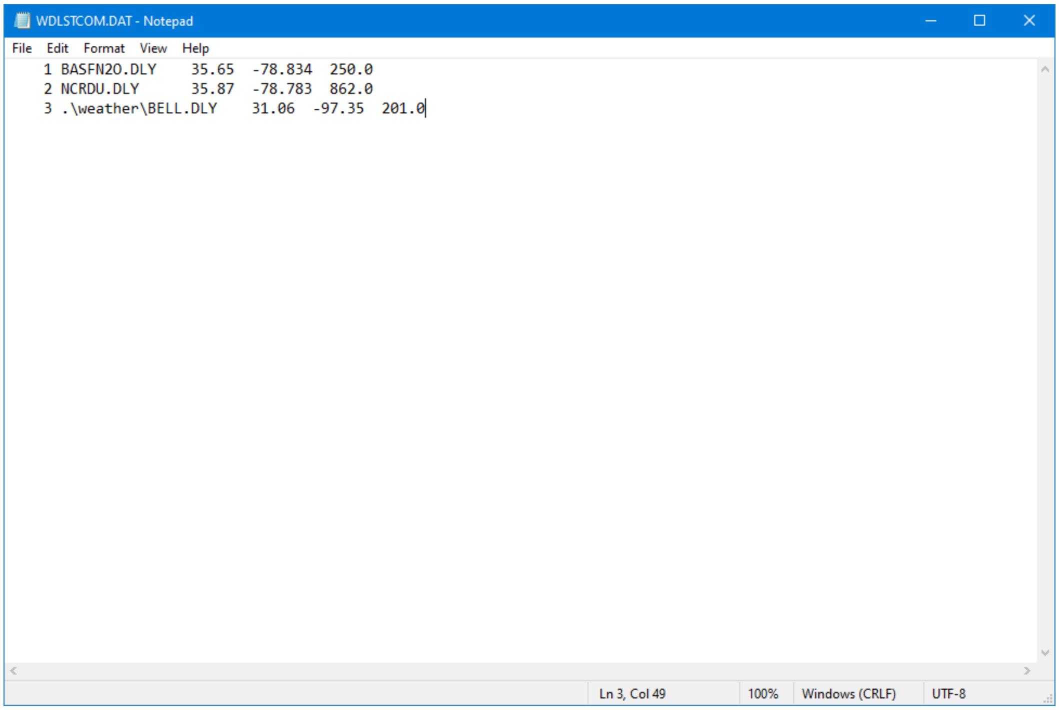
The EPIC daily weather list file is a listing of all daily weather files (weather stations) which have been previously created (see next section for details on how to create a daily weather file) and are available for use in creating runs. The daily weather list consists of a numbered listing of all daily weather files which can be referenced by number in the EPICRUN.DAT file. The name of the daily weather list file may be user defined; however, it must be properly identified in the EPICFILE.DAT file.

Table 12. Variables included in the EPIC daily weather list file.

Line - Field	Variable name	Description
L1-n – F1	`II`	Daily weather file ID Unique number to identify the daily weather file. This number is used in EPICRUN.DAT file to select the daily weather file used in each simulation (IWTH).
L1-n – F2	`OPSCFILE`	Daily weather file name Name of the daily weather file (including the extension of the file) or path + name of the daily weather file (including the extension). When using the name of the daily weather file, the file must be in the same folder as the EPIC executable. When using the path + file name, no spaces can be included in the path.
L1-n – F3	Y	Latitude (decimal degrees) Latitude of the weather station where the daily weather data was recorded. If a value for IWTH is not provided in the in the EPICRUN, the latitude of the weather stations is used to find the closest weather station considering the information provided in the site file (YLAT, XLOG, and ELEV). Latitudes in the Southern Hemisphere are in negative degrees and positive in the Northern Hemisphere. The automated identification of the weather station based on coordinates and elevation is affected by PARM(79). *(Range: -90 to 90)*

Line - Field	Variable name	Description
L1-n – F4	X	Longitude (decimal degrees) Longitude of the weather station where the daily weather data was recorded. If a value for IWTH is not provided in the in the EPICRUN, the longitude of the weather stations is used to find the closest weather station considering the information provided in the site file (YLAT, XLOG, and ELEV). The automated identification of the weather station based on coordinates and elevation is affected by PARM(79). *(Range: -180 to 180)*
L1-n – F5	ELEX	Elevation (meters) Elevation of the weather station where the daily weather data was recorded. If a value for IWTH is not provided in the in the EPICRUN, the longitude of the weather stations is used to find the closest weather station considering the information provided in the site file (YLAT, XLOG, and ELEV). The automated identification of the weather station based on coordinates and elevation is affected by PARM(79). *(Range: -200 to 8000)*

Figure 10. Example of EPIC daily weather list file. In this example, the daily weather files BASFN2O.DLY,NCRDU.DLY are in the same directory of the EPIC executable while the daily weather file "BELL.DLY" is in the folder "weather" which is located in the same folder where the EPIC executable is.



EPIC daily weather file (*filename*.DLY)

File format: two spaces, 3 fields of 4 characters each (integers), 7 fields of 6 characters each (floating).

Daily weather data can be used in two ways: First, it can be directly used in EPIC simulation when the length of the simulation is the same or less than the historical daily weather. Second, in general the historical daily weather data can be used to generate monthly weather data using the WXPM program, which then is used to generate EPIC weather input data directly by the EPIC model or using the WXGN weather generator. Both WXPM and WXGN are available at the EPIC/APEX software page of the BREC website.
Daily weather data is maintained in separate files named *filename*.DLY. These files must be listed in the EPIC daily weather list file WDLSTCOM.DAT (or user-defined name) with a unique reference number, which corresponds to the variable IWTH in the run file EPICRUN.DAT.

Each day of the time series takes one line of the daily weather file. A continuous series of dates is required. Leap years can be consistently considered or ignored and variable LPYR in the EPIC control file must be set accordingly. Elements included in the daily weather file are listed below.

Line - Field	Variable name	Description
L1-n – F1		Year *(cols. 3-6)* It is required and must be in 4-digit format (YYYY)
L1-n – F2		Month of the year *(cols. 7-10)* It is required. *(Range: 1 to 12)*
L1-n – F3		Day of the month *(cols. 11-14)* It is required. *(Range: 1 to 31)*
L1-n – F4	SRAD	Solar radiation (MJ m^{-2} or Ly) *(cols. 15-20)* It refers to the total solar radiation that reaches the Earth's surface. Solar radiation can be provided in mega Joules per square meter or in Langley (1 Ly = 41840 J m^{-2}). If this information is not available, leave it blank or use value 999.0 to allow the model to generate it. *(Range: 0.01 to 900.0)*

Line - Field	Variable name	Description
L1-n – F5	TMX	Maximum air temperature (°C) *(cols. 21-26)* Data on maximum air temperature is not required. Value 999.0 must be used if this information is not available or for missing data to allow the model to generate it. *(Range: -50.0 to 100.0)*
L1-n – F6	TMN	Minimum air temperature (°C) *(cols. 27-32)* Data on minimum air temperature is not required. Value 999.0 must be used if this information is not available or for missing data to allow the model to generate it. *(Range: -50.0 to 100.0)*
L1-n – F7	RFV	Precipitation (mm) *(cols. 33-38)* Data on precipitation is required. In case of missing data, value 999.0 can be used to generate occurrence and amount while any negative value can be used to generate amount given occurrence. *(Range: 0.0 to 900.0)*
L1-n – F8	RHD	Relative humidity (fraction) *(cols. 39-44)* It is not required and if provided must be in fraction format. Data can be provided as dew point temperature and the model will convert it into relative humidity. If data is not available, value 999.0 can be used to generate it. (Range: 0.01 to 1.0 for input relative humidity; <0.0 to >1.0 for input dew point temperature)
L1-n – F9	U10	Wind velocity (m sec^{-1}) *(cols. 45-50)* Wind speed velocity is not required. Value of 0.0 or 999.0 can be used if this information is not available. *(Range: 0.01 to 900)*
L1-n – F10	X1	Atmospheric CO_2 concentration (ppm) *(cols. 51-56)* Information on the atmospheric CO_2 concentration ca be provided. Values can be provided at any time intervals. CO_2 concentration is kept constant between values provided by the user. *(Range: 0.0 to 999.0)*

Line - Field	Variable name	Description
L1-n – F11	EVI	Vegetation index *(cols. 57-62)* Vegetation index EVI from remote sensing can be provided here. If provided, IEVI in the control table must be set accordingly. *(Range: -1.0 to 1.0)*

Figure 11. Example of a daily weather file used in EPIC1102. In this example, on January 10th 1990 all weather data are missing and the code 999.0 is used to generate all the weather variables. Also, atmospheric CO_2 concentration of 382.0 ppm is set on January 1st 1990. This value will be used until February 1st when a new value (383.0) is provided.

```
NCRDU.DLY - Notepad
File  Edit  Format  View  Help
  1990   1   1   5.9 17.78  6.67  8.38  0.99  2.40 382.0
  1990   1   2  11.3  7.78 -2.78  0.00  0.79  1.31
  1990   1   3  12.0  8.89 -2.78  0.00  0.79  4.43
  1990   1   4  10.7 13.89  2.78  0.00  0.33  2.99
  1990   1   5  10.4 16.67 10.56  0.00  0.40  4.13
  1990   1   6   4.5 15.56  8.89  7.62  0.78  3.22
  1990   1   7   6.4 12.22  5.00  2.03  0.99  3.12
  1990   1   8   4.3  8.33  4.44 11.94  0.79  2.13
  1990   1   9   5.2  7.22  1.11  7.11  0.99  4.45
  1990   1  10 999.0 999.0 999.0 999.0 999.0 999.0
  1990   1  11  10.7 15.00 -0.56  0.00  0.46  1.27
  1990   1  12  11.5 17.78  1.67  0.00  0.69  3.36
  1990   1  13  11.4 10.56 -2.22  0.00  0.74  2.29
  1990   1  14  11.2  6.67 -2.22  0.00  0.65  2.32
  1990   1  15  11.7 11.11 -2.22  0.00  0.61  3.84
  1990   1  16  11.2 17.78  6.11  0.00  0.52  3.17
  1990   1  17  11.2 20.00  6.67  0.00  0.45  3.16
  1990   1  18  11.7 22.22  8.89  0.00  0.76  2.17
  1990   1  19  11.5 20.00  9.44  0.00  0.71  4.34
  1990   1  20  11.7 12.22  5.56  0.00  0.67  1.74
  1990   1  21   5.6 15.00  5.56 26.67  0.99  3.14
  1990   1  22  12.3 18.89  3.89  0.00  0.55  3.85
  1990   1  23  11.8 15.56  3.89  0.00  0.46  2.32
  1990   1  24  12.8 17.22  5.00  0.00  0.63  2.80
  1990   1  25   7.7 12.78  8.89  1.52  0.99  2.80
  1990   1  26   8.4 24.44  5.00 19.30  0.92  3.08
  1990   1  27  13.5  7.78 -0.56  0.00  0.53  2.20
  1990   1  28  12.2 12.78  1.67  0.00  0.54  2.82
  1990   1  29  12.7 16.67  5.00  0.00  0.60  3.70
  1990   1  30   8.1 22.22  1.67  3.81  0.94  1.59
  1990   1  31  11.9 12.22  2.78  0.00  0.42  1.00
  1990   2   1  13.0 16.11  2.22  0.00  0.48  2.68 383.0
  1990   2   2  14.0 18.89  3.89  0.00  0.59  3.16
  1990   2   3  12.6 22.78 14.44  0.00  0.52  1.55
  1990   2   4  10.8 22.78  9.44  3.05  0.99  3.71
  1990   2   5  10.9 21.67  2.22  9.14  0.84  1.55
  1990   2   6  14.2 10.00  1.67  0.00  0.32  5.59
  1990   2   7   0.8 16.11  3.33  2.54  0.81  3.94
  1990   2   8  12.3 18.89  5.00  0.00  0.60  4.33
  1990   2   9  14.6 17.78  5.56  0.00  0.27  3.88
Ln 24852, Col 57   100%   Windows (CRLF)   UTF-8
```

EPIC monthly weather statistics list file (WPM1USEL.DAT)

File format: space delimited.

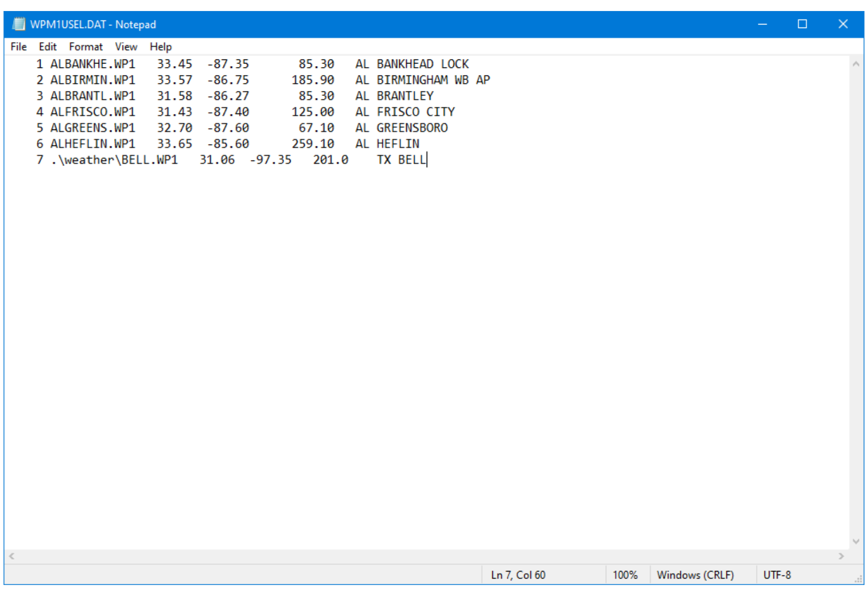
The EPIC monthly weather statistics list file is a listing of all monthly weather statistics files (associated to the weather stations) which have been previously created using the WXPM program. The monthly weather statistics list consists of a numbered listing of all monthly weather statistics files which can be referenced by number in the EPICRUN.DAT file. The name of the monthly weather statistics list file may be user defined; however, it must be properly identified in the EPICFILE.DAT file.

Table 13. Variables included in the EPIC monthly weather statistics list file.

Line - Field	Variable name	Description
L1-n – F1	`II`	Monthly weather statistics file ID Unique number to identify the monthly weather statistics file. This number is used in EPICRUN.DAT file to select the daily weather file used in each simulation (IWP1).
L1-n – F2	`OPSCFILE`	Monthly weather statistics file name Name of the monthly weather statistics file (including the extension of the file) or path + name of the management file (including the extension). When using the name of the monthly weather statistics file, the file must be in the same folder of the EPIC executable. When using the path + file name, no spaces can be included in the path.
L1-n – F3	Y	Latitude (decimal degrees) Latitude of the weather station where the weather data was recorded. If a value for IWP1 is not provided in the in the EPICRUN, the latitude of the weather stations is used to find the closest weather station considering the information provided in the site file (YLAT, XLOG, and ELEV). Latitudes in the Southern Hemisphere are in negative degrees and positive in the Northern Hemisphere. The automated identification of the weather station based on coordinates and elevation is affected by PARM(79). *(Range: -90 to 90)*

Line - Field	Variable name	Description
L1-n – F4	X	Longitude (decimal degrees) Longitude of the weather station where the weather data was recorded. If a value for IWP1 is not provided in the in the EPICRUN, the longitude of the weather stations is used to find the closest weather station considering the information provided in the site file (YLAT, XLOG, and ELEV). The automated identification of the weather station based on coordinates and elevation is affected by PARM(79). *(Range: -180 to 180)*
L1-n – F5	ELEX	Elevation (meters) Elevation of the weather station where the weather data was recorded. If a value for IWP1 is not provided in the EPICRUN, the elevation of the weather station is used to find the closest weather station considering the information provided in the site file (YLAT, XLOG, and ELEV). The automated identification of the weather station based on coordinates and elevation is affected by PARM(79). *(Range: -200 to 8000)*

Figure 12. Example of EPIC monthly weather statistics list file. In this example, the files from 1 to 6 are in the same directory of the EPIC executable while the file "BELL.WP1" is in the folder "weather" which is located in the same folder where the EPIC executable is.




```
    1 ALBANKHE.WP1   33.45  -87.35       85.30   AL BANKHEAD LOCK
    2 ALBIRMIN.WP1   33.57  -86.75      185.90   AL BIRMINGHAM WB AP
    3 ALBRANTL.WP1   31.58  -86.27       85.30   AL BRANTLEY
    4 ALFRISCO.WP1   31.43  -87.40      125.00   AL FRISCO CITY
    5 ALGREENS.WP1   32.70  -87.60       67.10   AL GREENSBORO
    6 ALHEFLIN.WP1   33.65  -85.60      259.10   AL HEFLIN
    7 .\weather\BELL.WP1    31.06  -97.35    201.0    TX BELL
```

EPIC monthly weather statistics file (*filename*.WP1)

File format: different formats are used to read the monthly weather statistics file.

Line 1 – 2: free format

Line 3 – 16: 12 fields of 6 characters each with two decimals digits (floating).

The monthly weather statistics file contains statistical information calculated using the daily weather data. The statistics can be calculated using the program WXPM available at the EPIC/APEX software page of the BREC website. When NGN in the EPICCONT.DAT file is equal to 0 or -1, this indicates that monthly weather is to be used to generate all weather variables (or some of them depending on the NGN setting). Monthly weather is also used to generate weather when no daily weather data is available.

In the monthly weather statistics, different variables are organized in rows, while months are organized in columns. Elements included in the monthly weather statistics file are listed below.

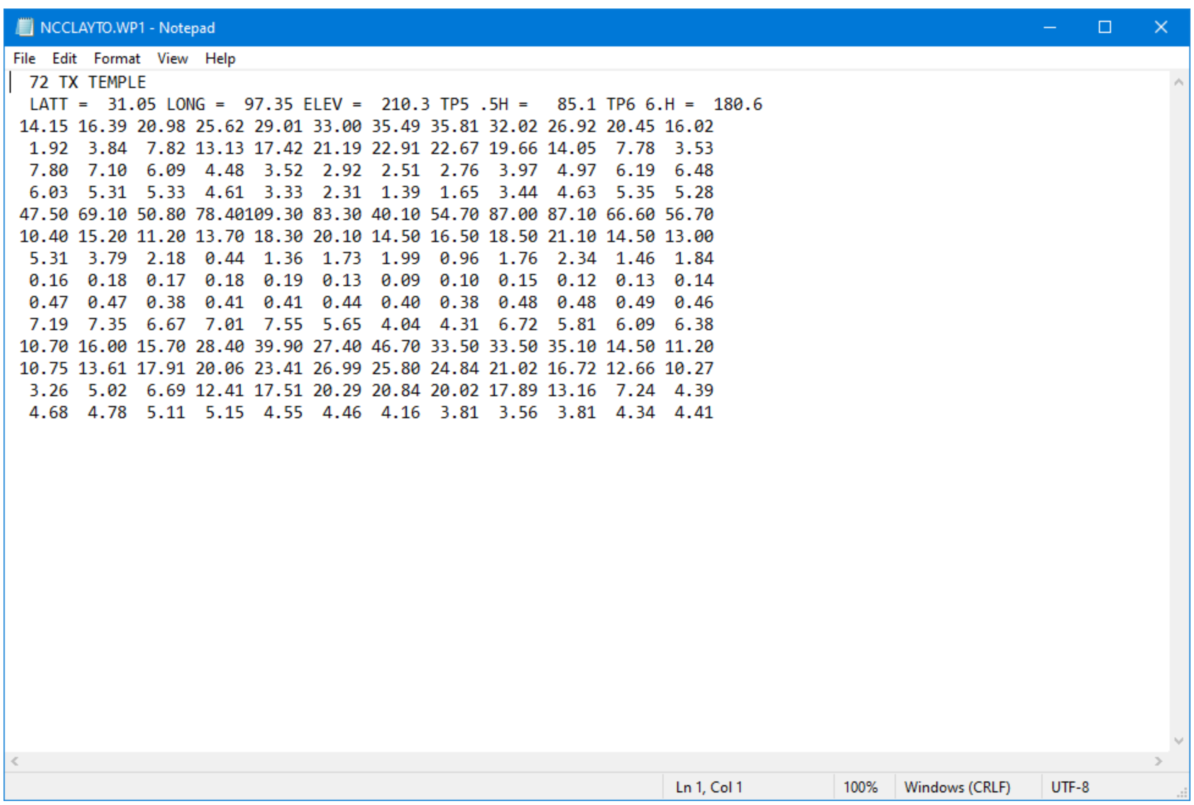
Line	Variable name	Description
3	OBMX	Average monthly maximum air temperature (°C)
4	OBMN	Average monthly minimum air temperature (°C)
5	SDTMX	Monthly standard deviation of max temperature or extreme max temperature (monthly) (°C) The extreme monthly maximum temperature can be provided if the standard deviation is not available.
6	SDTMN	Monthly standard deviation of min temperature or extreme min temperature (monthly) (°C) The extreme monthly minimum temperature can be provided if the standard deviation is not available.
7	RMO	Average monthly precipitation (mm)
8	RST(2)	Monthly standard deviation of daily rainfall (mm) Can be left blank if unknown or if daily precipitation is provided in the daily weather file.

Line	Variable name	Description
9	`RST(3)`	Monthly skew coefficient of daily rainfall Can be left blank if unknown or if daily precipitation is provided in the daily weather file.
10	`PBW(1)`	Monthly probability of wet day after dry day Can be left blank if unknown or if daily precipitation is provided in the daily weather file.
11	`PBW(2)`	Monthly probability of wet day after wet day Can be left blank if unknown or if daily precipitation is provided in the daily weather file.
12	`UAVM`	Average number of days of precipitation per month Blank if precipitation is generated and PBW(1) and (2) are input.
13	`WI`	Three meanings are available • Monthly maximum 0.5 hour rainfall (mm) for period in YWI (in EPICCONT.DAT) • Alpha (mean 0.5 hour rain/mean storm amount) • 0.0 if unknown
14	`OBSL`	Average monthly solar radiation (MJ m^{-2} or Ly) Blank if unknown.
15	`RH`	Three meanings are available *(cols. 1-6)* • Average monthly relative humidity (fraction) *(Range: 0 to 1)* • Average monthly dew point (°C) • Blank if unknown
16	`UAV0`	Average monthly wind velocity (m sec^{-1})

Columns allocated to each month are as follows

Month	Columns
January	1 to 6
February	7 to 12
March	13 to 18
April	19 to 24
May	25 to 30
June	31 to 36
July	37 to 42
August	43 to 48
September	49 to 54
October	55 to 60
November	61 to 66
December	67 to 72

Figure 13. Example of monthly weather statistics file used in EPIC1102.




```
 72 TX TEMPLE
 LATT =  31.05 LONG =  97.35 ELEV =  210.3 TP5 .5H =   85.1 TP6 6.H =  180.6
14.15 16.39 20.98 25.62 29.01 33.00 35.49 35.81 32.02 26.92 20.45 16.02
 1.92  3.84  7.82 13.13 17.42 21.19 22.91 22.67 19.66 14.05  7.78  3.53
 7.80  7.10  6.09  4.48  3.52  2.92  2.51  2.76  3.97  4.97  6.19  6.48
 6.03  5.31  5.33  4.61  3.33  2.31  1.39  1.65  3.44  4.63  5.35  5.28
47.50 69.10 50.80 78.40109.30 83.30 40.10 54.70 87.00 87.10 66.60 56.70
10.40 15.20 11.20 13.70 18.30 20.10 14.50 16.50 18.50 21.10 14.50 13.00
 5.31  3.79  2.18  0.44  1.36  1.73  1.99  0.96  1.76  2.34  1.46  1.84
 0.16  0.18  0.17  0.18  0.19  0.13  0.09  0.10  0.15  0.12  0.13  0.14
 0.47  0.47  0.38  0.41  0.41  0.44  0.40  0.38  0.48  0.48  0.49  0.46
 7.19  7.35  6.67  7.01  7.55  5.65  4.04  4.31  6.72  5.81  6.09  6.38
10.70 16.00 15.70 28.40 39.90 27.40 46.70 33.50 33.50 35.10 14.50 11.20
10.75 13.61 17.91 20.06 23.41 26.99 25.80 24.84 21.02 16.72 12.66 10.27
 3.26  5.02  6.69 12.41 17.51 20.29 20.84 20.02 17.89 13.16  7.24  4.39
 4.68  4.78  5.11  5.15  4.55  4.46  4.16  3.81  3.56  3.81  4.34  4.41
```

EPIC wind data list file (WINDUSEL.DAT)

File format: space delimited.

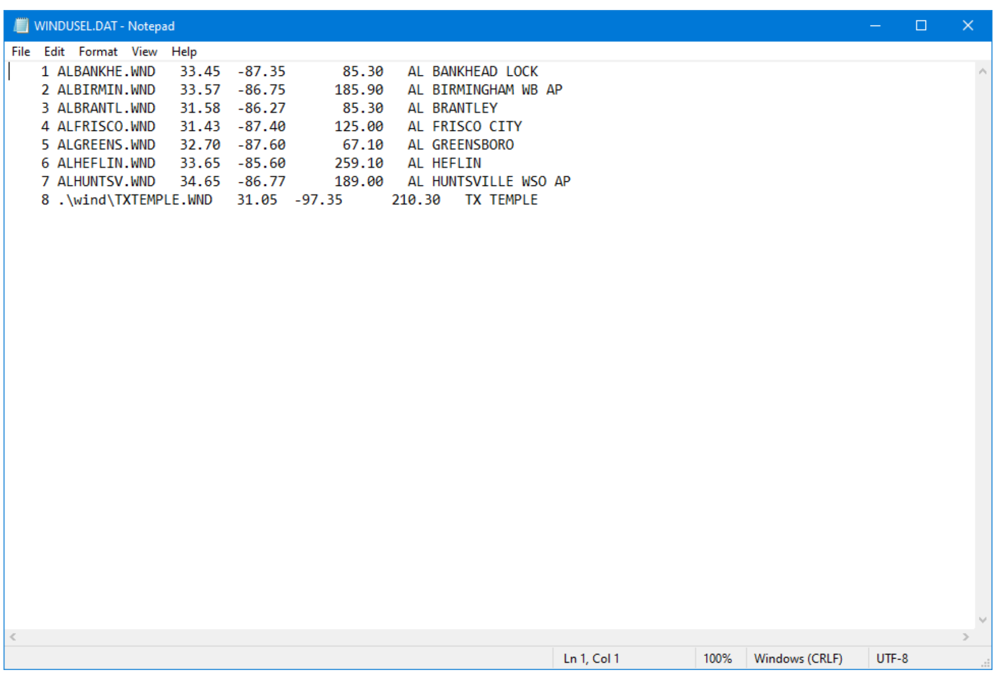
The EPIC wind data list file is a listing of all wind station files which have been previously created (see next section for details on how to create a wind data file) and are available for use in creating runs. The wind data list file consists of a numbered listing of all wind stations which can be referenced by number in the EPICRUN.DAT file. The name of the wind data list file may be user defined; however, it must be properly identified in the EPICFILE.DAT file.

Table 14. Variables included in the EPIC weather data list file.

Line - Field	Variable name	Description
L1-n – F1	II	Wind data file ID Unique number to identify the wind data file. This number is used in EPICRUN.DAT file to select the daily weather file used in each simulation (IWND).
L1-n – F2	OPSCFILE	Wind data file name Name of the wind data file (including the extension of the file) or path + name of the wind data file (including the extension). When using the name of the wind data, the file must be in the same folder of the EPIC executable. When using the path + file name, no spaces can be included in the path.
L1-n – F3	Y	Latitude (decimal degrees) Latitude of the wind station where the wind data was recorded. If a value for IWND is not provided in the in the EPICRUN, the latitude of the wind stations is used to find the closest wind station considering the information provided in the site file (YLAT, XLOG, and ELEV). Latitudes in the Southern Hemisphere are in negative degrees and positive in the Northern Hemisphere. The automated identification of the weather station based on coordinates and elevation is affected by PARM(79). *(Range: -90 to 90)*
L1-n – F4	X	Longitude (decimal degrees) Longitude of the wind station where the wind data was recorded. If a value for IWND is not provided in the in the EPICRUN, the longitude of the wind stations is used to find the closest wind station

Line - Field	Variable name	Description
L1-n – F4 (cont.)	X (cont.)	considering the information provided in the site file (YLAT, XLOG, and ELEV). The automated identification of the wind station based on coordinates and elevation is affected by PARM(79). *(Range: -180 to 180)*
L1-n – F5	ELEX	Elevation (meters) Elevation of the wind station where the wind data was recorded. If a value for IWND is not provided in the in the EPICRUN, the longitude of the wind stations is used to find the closest wind station considering the information provided in the site file (YLAT, XLOG, and ELEV). The automated identification of the wind station based on coordinates and elevation is affected by PARM(79). *(Range: -200 to 8000)*

Figure 14. Example of EPIC wind data list file. In this example, the wind data files from 1 to 7 are in the same directory of the EPIC executable while the wind data file "TXTEMPLE.WND" is in the folder "wind" which is located in the same folder where the EPIC executable is.



```
WINDUSEL.DAT - Notepad
File  Edit  Format  View  Help
    1 ALBANKHE.WND    33.45  -87.35       85.30    AL BANKHEAD LOCK
    2 ALBIRMIN.WND    33.57  -86.75      185.90    AL BIRMINGHAM WB AP
    3 ALBRANTL.WND    31.58  -86.27       85.30    AL BRANTLEY
    4 ALFRISCO.WND    31.43  -87.40      125.00    AL FRISCO CITY
    5 ALGREENS.WND    32.70  -87.60       67.10    AL GREENSBORO
    6 ALHEFLIN.WND    33.65  -85.60      259.10    AL HEFLIN
    7 ALHUNTSV.WND    34.65  -86.77      189.00    AL HUNTSVILLE WSO AP
    8 .\wind\TXTEMPLE.WND    31.05  -97.35      210.30    TX TEMPLE
Ln 1, Col 1    100%    Windows (CRLF)    UTF-8
```

EPIC monthly wind statistics file (*filename*.WND)

File format: different formats are used to read the monthly weather statistics file.

Line 1 – 2: free format

Line 3 – 19: 12 fields of 6 characters each with two decimals digits (floating).

The monthly wind statistics file contains statistical information calculated using the daily weather data. The file contains information on the monthly average wind speed and the frequency from 16 directions. This file is crucial for wind erosion and dust distribution simulation.

In the monthly wind statistics, months are organized in columns, the third row indicates the average wind speed, and the remaining columns indicate the different wind directions. Elements included in the monthly wind statistics file are listed below.

Line	Variable name	Description
3	UAVM	Average monthly wind speed (m s^{-1}) Wind speed is measured at 10 m height. To convert 2 m height wind speed to a 10 m height equivalent multiply the 2 m height speed by 1.3. UAVM is required to simulate wind erosion (ACW > 0, see ACW in EPIC control file), and it is also required if Penman-Monteith equations are used to calculate potential evapotranspiration (see IET in EPIC control file).
4	DIR1	Monthly % wind from North. May be left zero if wind erosion is not estimated.
5	DIR2	Monthly % wind from North North East. May be left zero if wind erosion is not estimated.
6	DIR3	Monthly % wind from North East. May be left zero if wind erosion is not estimated.
7	DIR4	Monthly % wind from East North East. May be left zero if wind erosion is not estimated.
8	DIR5	Monthly % wind from East. May be left zero if wind erosion is not estimated.
9	DIR6	Monthly % wind from East South East. May be left zero if wind erosion is not estimated.

Line	Variable name	Description
10	DIR7	Monthly % wind from South East. May be left zero if wind erosion is not estimated.
11	DIR8	Monthly % wind from South South East. May be left zero if wind erosion is not estimated.
12	DIR9	Monthly % wind from South. May be left zero if wind erosion is not estimated.
13	DIR10	Monthly % wind from South South West. May be left zero if wind erosion is not estimated.
14	DIR11	Monthly % wind from South West. May be left zero if wind erosion is not estimated.
15	DIR12	Monthly % wind from West South West. May be left zero if wind erosion is not estimated.
16	DIR13	Monthly % wind from West. May be left zero if wind erosion is not estimated.
17	DIR14	Monthly % wind from West North West. May be left zero if wind erosion is not estimated.
18	DIR15	Monthly % wind from North West. May be left zero if wind erosion is not estimated.
19	DIR1	Monthly % wind from North North West. May be left zero if wind erosion is not estimated.

Figure 15. Example of monthly wind statistics file used in EPIC1102.

NCCLAYTO.WND - Notepad

```
TX TEMPLE
     .00     .00
      4.68      4.78      5.11      5.15      4.55      4.46      4.16      3.81      3.56      3.81      4.34      4.41
       14.       12.       11.        8.        6.        3.        2.        2.        8.       11.       13.       11.
        5.        6.        6.        5.        3.        2.        1.        2.        6.        5.        5.        4.
        3.        4.        4.        4.        3.        3.        2.        4.        8.        5.        4.        3.
        2.        3.        3.        3.        3.        2.        2.        3.        6.        3.        2.        1.
        2.        4.        4.        3.        4.        4.        3.        5.        7.        4.        2.        2.
        2.        3.        3.        4.        5.        4.        4.        6.        6.        4.        2.        2.
        6.        7.        8.       11.       13.       14.       13.       13.       11.       10.        6.        6.
       10.       10.       13.       20.       22.       24.       22.       19.       13.       14.       12.       10.
       18.       14.       18.       20.       23.       28.       30.       26.       17.       17.       19.       18.
        8.        6.        6.        5.        5.        7.       12.       10.        5.        6.        7.        7.
        4.        4.        3.        2.        2.        3.        4.        5.        3.        3.        4.        5.
        3.        2.        2.        1.        1.        1.        2.        1.        1.        1.        2.        3.
        3.        3.        3.        2.        1.        1.        1.        1.        1.        2.        3.        4.
        3.        3.        3.        2.        2.        1.        0.        1.        1.        2.        3.        3.
        7.        7.        5.        4.        3.        1.        1.        1.        3.        5.        7.       10.
       11.       10.        8.        6.        3.        2.        1.        1.        4.        7.       10.       12.
```

EPIC tillage and equipment list file (TILLCOM.DAT)

File format: different formats are used to read the tillage and equipment list file.

Line 1 – 2: headers not used in the simulation

Line 3 – n: fixed format with

- *one space*
- *one integer with four characters*
- *one space*
- *one string with eight characters*
- *one space*
- *one string with four characters*
- *28 fields of 8 characters each (floating)*

The EPIC tillage and equipment list file includes all the tractors and equipment that can be simulated by the EPIC model. The equipment and machines included in the file are commonly used in agricultural land. Each implement or operation take one row of the tillage and equipment list file and is described using 28 parameters. New equipment and machines can be added by the user at the end of the file providing all the parameters required to describe the operation or the implement. Elements included in the EPIC tillage and equipment list file are listed below.

Field	Variable name	Description
	J2	Machine or equipment ID *(cols. 2-5)* Unique number to identify the machine or equipment. This number is used in the EPIC management file (JX(4), or JX(5) for tractor, in OPSCCOM.DAT) to identify the operation that must be simulated or the tractor used for that operation. *(Range: 1 to 9999)*
	TIL	Machine or equipment name *(cols.7-14)* Abbreviation of the name of the machine or equipment.
	PCD	Power code *(cols. 16-19)* It is used as first identification of the machine or equipment. Only five options are allowed. • POWE: for machines with its own engine generally used to pull other machinery or equipment (e.g., tractor).

Field	Variable name	Description
	PCD (cont.)	• SELF: for machines with its own engine and that do the operation by itself (e.g., combine). • NON: the machine or equipment has no engine for power, and it must be pulled by other machinery with engine power. • IRRI: equipment for irrigation. • CUST: customized equipment.
1	PRIC	Purchase price ($) *(cols. 20-27)* The amount of money the equipment was purchased for. To estimate purchase price, subtract 10% from the initial list price. EXCEPTION: for a custom operation = cost ($/ha). Used only for economic analysis. *(Range: 0 to 999999)*
2	XLP	Initial list price in current ($) *(cols. 28-35)* The price of the equipment when new. Used only for economic analysis. *(Range: 0 to 999999)*
3	HRY	Annual use (h) *(cols. 36-43)* The amount of time per year the equipment is used. Used only for economic analysis. *(Range: 0 to 8760)*
4	HRL	Life of equip (h) *(cols. 44-51)* The amount of time the equipment will be capable of being used. Used only for economic analysis. *(Range: 0 to 999999)*
5	PWR	Power of unit (KW) *(cols. 52-59)* This is the horsepower or the number of kilowatts of the equipment. Used only for economic analysis. Kilowatts x 1.341 = horsepower *(Range: 0 to 900)*

Field	Variable name	Description
6	`WDT`	Width of pass (m) *(cols. 60-67)* This refers to the width the equipment covers when it is moved across the land. Used only for economic analysis. *(Range: 0 to 50)*
7	`SPD`	Operating speed (km h^{-1}) *(cols. 68-75)* The speed at which the equipment is operated at. Used only for economic analysis. *(Range: 0 to 200)*
8	`RC1`	Repair cost coefficient 1 *(cols. 76-83)* Refer to the American Society of Agricultural Engineers Standards Engineering Practices Data handbook for this value. Used only for economic analysis. *(Range: 0 to 1)*
9	`RC2`	Repair cost coefficient 2 *(cols. 84-91)* Refer to the American Society of Agricultural Engineers Standards Engineering Practices Data handbook for this value. *(Range: 0 to 5)*
10	`XLB`	Lubricant factor *(cols. 92-99)* Refer to the American Society of Agricultural Engineers Standards Engineering Practices Data handbook for this value. Used only for economic analysis. *(Range: 0 to 1)*
11	`FCM`	Fuel consumption multiplier *(cols. 100-107)* Refer to the American Society of Agricultural Engineers Standards Engineering Practices Data handbook for this value. Used only for economic analysis. *(Range: 0 to 1)*

Field	Variable name	Description
12	RFV1	Remaining farm value parameter 1 *(cols. 108-115)* Refer to the American Society of Agricultural Engineers Standards Engineering Practices Data handbook for this value. Used only for economic analysis. *(Range: 0 to 2)*
13	RFV2	Remaining farm value parm 2 *(cols. 116-123)* Refer to the American Society of Agricultural Engineers Standards Engineering Practices Data handbook for this value. Used only for economic analysis. *(Range: 0 to 2)*
14	EFM	Machine efficiency *(cols. 124-131)* The fraction of efficiency loss due to the overlap of passes. For example, if each time a pass is made across the field, the implement covers 10% of the last pass, then the machine efficiency is 0.90. In the case of irrigation systems, this machine efficiency applies to the efficiency of the system. This would include losses from the well or channel to the soil surface. These losses include leaks in channels, pipes, and other equipment deficiencies as well as evaporation of water before it reaches the soil surface as is the case with sprinkler irrigation systems. *(Range: 0-1)* EFM is also used for specific operations like grazing and mulching with plastic films. In the case of grazing (IHC = 19) EFM has the meaning of grazing rate and is input as kg $head^{-1}$ day^{-1}. *(Range: 0.1-99999.9)* In the case of the use of plastic cover (IHC = 23), EFM indicates the fraction of unit area covered by the plastic film. *(Range: 0 to 1)*
15	RTI	Annual real interest rate ($/$) *(cols. 132-139)* The difference between the nominal interest rate (current rate of interest) and the inflation rate. *(Range: 0.001 to 0.15)*

Field	Variable name	Description
16	EMX	Mixing efficiency *(cols: 140-147)* The mixing efficiency of the operation is the fraction of materials (crop residues, pesticides, and nutrients) on the soil surface that is mixed uniformly in the plow depth of the implement. The remaining fraction of the residue and nutrients is left in the original location (soil surface or layer). *(Range: 0 to 0.99)*
17	RR	Random surface roughness created by tillage operation in mm *(cols. 148-155)* This characterizes the soil surface roughness due to soil aggregates. Random roughness has been used to describe the effects of tillage on surface roughness and to estimate the surface roughness after tillage based on the tillage implement used. (Potter, K.N. 1990. Soil properties effect random roughness decay by rainfall. Transactions of the ASAE 33 (6) 1889-1892.) The random roughness index is the standard error of adjusted natural log transformed surface elevations. *(Range: 0 to 100)* RR is also used in simulating the use of plastic cover and represents the albedo of the surface after placing the plastic cover. *(Range: 0 to 1)*
18	TLD	Tillage depth in mm *(cols. 156-163)* Depending on the operation that is simulated, positive or negative number are used as follows: • Positive numbers are used for depth below the soil surface. • Negative numbers are used operations that occur above the soil surface (e.g., cutting height). • Zero value is used for operation that occurs on the soil surface (e.g., broadcast fertilization). *(Range: -2000 to 2000)*
19	RHT	Ridge height in mm *(cols. 164-171)* The height of the ridge created by the implement. This affects wind erosion. *(Range: 0 to 1000)*

Field	Variable name	Description
20	`RIN`	Ridge interval in m *(cols. 172-179)* The distance between ridges created by the implement. Also known as row spacing. To set the row spacing of the crop, the ridge interval should be set depending on the planter used. *(Range: 0 to 200)*
21	`DKH`	Height of furrow dikes in mm *(cols. 180-187)* This will affect the amount of water the furrow dike is capable of storing. *(Range: 0 to 1000)*
22	`DKI`	Distance between furrow dikes in m *(cols. 188-195)* *(Range: 0 to 200)*
23	`IHC`	Operation code *(cols. 196-203)* Code used to identify the type of operation or implement. Accepted values are: 0 Plow, cultivate, other 1 Kill crop (terminates the simulation of crop, all biomass is converted in residue) 2 Harvest without kill (a harvest operation is simulated giving yield in the output files. The plant will continue to grow after the harvest operation. NOTE: mowing operations with IHC zero do not simulate a harvest operation and yield won't be simulated). 3 Harvest once during simulation without kill 4 Tractor 5 Plant in rows 6 Plant with drill 7 Apply pesticide 8 Irrigate 9 Fertilize 10 Bagging and ties (cotton) 11 Ginning 12 Hauling

Field	Variable name	Description
23 (cont.)	IHC (cont.)	13 Drying 14 Burn 15 Puddle (used for paddy-rice simulation) 16 Destroy puddle (used for paddy-rice simulation) 17 Builds furrow dikes 18 Destroy furrow dikes 19 Start grazing 20 Stop grazing 21 Auto mow 22 Plastic cover 23 Remove plastic cover 24 Stop drainage system flow 25 Resume drainage system flow
24	HE	Harvest efficiency or pesticide application efficiency *(cols. 204-211)* As a harvest operation (IHC = 2) this is the ratio of the crop yield removed from the field to the total crop yield. It is used also for grazing as grazing efficiency (fraction of the total available area that is actually grazed). As pesticide application efficiency (IHC = 7) it is the fraction of the pesticide which is deposited on the foliage or soil surface while the remaining is lost. Beside its normal function, harvest efficiency can be used in simulating growing green manure crop (HE = 0) when all the above-ground biomass is left on the field. *(Range: 0 to 1)*
25	ORHI	Override harvest index for forage and root crops *(cols. 212-219)* This is the ratio of the economic or harvestable yield to the total biomass of the crop. This value overrides the harvest index set in the EPIC plant list file (CROPCOM.DAT) if a forage or root crop is chosen. In the case of grazing, ORHI is calculated by the model as EFM × 0.001. As the crop grows, these values may be adjusted for water stress. For some crops like hay, the harvest index is not affected by water stress. Thus, the harvest index override (ORHI) is used to give a constant harvest index. Another important feature of ORHI is the provision for two different types of harvest of the same crop. For example, the seed could be removed from a crop and later the straw could be baled. The water-stress-adjusted HI is appropriate for the seed harvest but probably not for baling the straw. Thus, two separate harvest machines are required. The second harvester sets ORHI approx. equal to 0.9 to override the adjusted HI used in the first harvest. *(Range: 0 to 1)*

Field	Variable name	Description
26	`FRCP`	Fraction of soil compacted *(cols. 220-227)* Calculated as tire width / tillage width Experimental and currently not activated in the simulation. *(Range: 0 to 1)*
27	`FPOP`	Fraction of plant population reduced by operation *(cols. 228-235)* This operation can be used for thinning operations to reduce the plant population which was actually planted. It can also be used to decrease plant population after a harvest (i.e., sugarcane) or due to a tillage operation. It is a correction to the seeded rate. Each time an operation that has an FPOP >0 occurs, the current plant population is reduced accordingly. *(Range: 0 to 1)*
28	`TCEM`	Carbon emission (kg ha^{-1}) *(cols. 236-243)* Carbon emitted from use of equipment. *(Range: 0 to 9999)*

Figure 16. Example of TILLCOM.DAT file with the list of machines and implements available for simulation in EPIC1102.

TILLCOM.DAT - Notepad

#	NAME	PCD	1 PRIC	2 PLST	3 HRY	4 HRL	5 PWR	6 WDT	7 SPD	8 RC1	9 RC2	10 XLB	11 FCM	12 VR1	13 VR2	14 EFM	15 RTI
1	TR2W40LP	POWE	16237	17861	320	12000	30	0.3	0.00	0.007	2.000	0.100	0.680	0.680	0.920	0.000	0.000
2	TR2W40GS	POWE	16600	18260	320	12000	30	0.3	0.00	0.007	2.000	0.100	0.530	0.680	0.920	0.000	0.000
3	TR2W40DS	POWE	16600	18260	320	12000	30	0.3	0.00	0.007	2.000	0.100	0.420	0.680	0.920	0.000	0.000
4	TR2W55LP	POWE	22000	24200	340	12000	41	0.3	0.00	0.007	2.000	0.100	0.680	0.680	0.920	0.000	0.000
5	TR2W55GS	POWE	22000	24200	340	12000	41	0.3	0.00	0.007	2.000	0.100	0.530	0.680	0.920	0.000	0.000
6	TR2W55DS	POWE	22000	24200	340	12000	41	0.3	0.00	0.007	2.000	0.100	0.420	0.680	0.920	0.000	0.000
7	TR2W85LP	POWE	34200	37620	550	12000	63	0.3	0.00	0.007	2.000	0.100	0.680	0.680	0.920	0.000	0.000
8	TR2W85GS	POWE	34200	37620	550	12000	63	0.3	0.00	0.007	2.000	0.100	0.530	0.680	0.920	0.000	0.000
9	TR2W85DS	POWE	34200	37620	550	12000	63	0.3	0.00	0.007	2.000	0.100	0.420	0.680	0.920	0.000	0.000
10	TR2100LP	POWE	43400	47740	525	12000	75	0.3	0.00	0.007	2.000	0.100	0.680	0.680	0.920	0.000	0.000

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TILLCOM.DAT - Notepad

16 EMX	17 RR	18 TLD	19 RHT	20 RIN	21 DKH	22 DKI	23 IHC	24 HE	25 ORHI	26 FRCP	27 FPOP	28 CFEM	STIR	EQP
0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.0	0.000	0.000	0.000	0.000	0.000	10.0	TRACTOR 2WD 40 HP LP
0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.0	0.000	0.000	0.000	0.000	0.000	10.0	TRACTOR 2WD 40 HP GAS
0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.0	0.000	0.000	0.000	0.000	0.000	10.0	TRACTOR 2WD 40 HP DIESEL
0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.0	0.000	0.000	0.000	0.000	0.000	10.0	TRACTOR 2WD 55 HP LP
0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.0	0.000	0.000	0.000	0.000	0.000	10.0	TRACTOR 2WD 55 HP GAS
0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.0	0.000	0.000	0.000	0.000	0.000	10.0	TRACTOR 2WD 55 HP DIESEL
0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.0	0.000	0.000	0.000	0.000	0.000	10.0	TRACTOR 2WD 85 HP LP
0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.0	0.000	0.000	0.000	0.000	0.000	10.0	TRACTOR 2WD 85 HP GAS
0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.0	0.000	0.000	0.000	0.000	0.000	10.0	TRACTOR 2WD 85 HP DIESEL
0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.0	0.000	0.000	0.000	0.000	0.000	10.0	TRACTOR 2WD 100 HP LP

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NOTE: The last column with the machine or implement name is just for reference and it is not used by the model.

EPIC plant list file (CROPCOM.DAT)

File format: different formats are used to read the plant list file.

Line 1 – 2: headers not used in the simulation

Line 3 – n: fixed format with

- *one space*
- *one integer with four characters*
- *one space*
- *one string with four characters*
- *58 fields of 8 characters each (floating)*

The EPIC plant (or crop) list file includes all the plants (annuals, perennials, and trees) that can be simulated by the model. Each plant is characterized by 58 parameters, which are all put in a single row in the EPIC plant list file. New plants can be added by the user. The plant parameters already included in the EPIC plant list file should not be modified without a solid knowledge of plant growth and development and good knowledge on how the EPIC growth model works. Elements included in the EPIC plant list file are listed below.

Field	Variable name	Description
	`J2`	Plant ID *(cols. 2-5)* Unique number to identify the plant. This number is used in the EPIC management file (JX(6) in OPSCCOM.DAT) to identify the plant(s) that must be simulated.
	`CPNM`	Plant name *(cols. 7-10)* Short name of the plant. This will be used to represent the plant(s) in several output files.
1	`WA`	Biomass-Energy ratio *(cols. 11-18)* Also known as radiation use efficiency, it is the potential (unstressed) growth rate (including roots) per unit of intercepted photosynthetically active radiation. Values reported here are for atmospheric CO_2 concentration of 330 ppm. <u>This parameter should be one of the last to be adjusted</u>. Adjustments should be based on research results. This parameter can greatly change the rate of growth, incidence of stress during the season and the resultant yield. Care should be taken to make adjustments in the parameter only based on data with no drought, nutrient or temperature stress. *(Range: 0.01 to 90)*

Field	Variable name	Description
2	`HI`	Harvest index *(cols. 19-26)* The harvest index is the ratio of economic or harvestable yield to the total biomass of the plant. This plant parameter should be based on experimental data where plant stresses have been minimized to allow the plant to attain its potential. HI input here is the maximum harvest index that could possibly be attained under nonstresses conditions. The actual HI is adjusted during the simulation based on stress and phenological development. This variable only pertains to grain and cotton crops. For forage and root crops, the Override Harvest Index (ORHI) should be set in the TILLCOM.DAT file for the harvest equipment used to harvest the crop. *(Range: 0.01 to 1.0)*
3	`TOPC`	Optimal temperature for plant growth (°C) *(cols. 27-34)* This indicates the optimum temperature at which the plant will grow without being physiologically damaged by high or low temperatures. This value is very stable for cultivars within a species and should not be changed once determined for a species. Varietal or maturity type differences are accounted for by different sums of thermal units. *(Range: 0.0 to 40.0)*
4	`TBSC`	Minimum temperature for plant growth (°C) *(cols. 35-42)* This indicates the minimum (base) temperature at which the crop will grow without being physiologically damaged by cold. This value is very stable for cultivars within a species and should not be changed once determined for a species. Varietal or maturity type differences are accounted for by different sums of thermal units. *(Range: 0.0 to 25.0)*
5	`DMLA`	Maximum potential leaf area index *(cols. 43-50)* Leaf area index refers to the ratio of the surface area of the leaves (one side only) of the plant to the area of the ground covered by the plants. This parameter refers to the greatest leaf area index that the plant is able to attain. The DMLA is based on the highest expected plant densities for plants not expected to have water stress. DMLA is internally adjusted for drought-prone regions as planting densities are much smaller in these areas unless irrigation is used. *(Range: 0.1 to 20.0)*

Field	Variable name	Description
6	`DLAI`	Fraction of growing season when leaf area declines *(cols. 51-58)* Point in the growing season (expressed as a fraction of heat units required for maturation) when the leaf area index begins to decrease due to leaf senescence. The fraction of the growing season in heat units is divided by the total heat units accumulated between planting and crop maturity. *(Range: 0.01 to 1.0)*
7	`DLAP(1)`	First point on optimal leaf area development curve *(cols. 59-66)* This is the first of two points on the optimal (not stressed) leaf area development curve. Numbers before decimal are % of growing season. Numbers after decimal are fractions of maximum potential LAI. For example, 15.01 states that at 15% of the growing season, 1% of the LAI has developed. See Figure 17 for an example on how DLAP(1) works.
8	`DLAP(2)`	Second point on optimal leaf area development curve *(cols. 67-74)* This is the second of two points on optimal (not stressed) leaf area development curve. Numbers before decimal are % of growing season. Numbers after decimal are fractions of maximum potential LAI. For example, 50.95 states that at 50% of the growing season, 95% of the LAI has developed. See Figure 17 for an example on how DLAP(2) works.
9	`RLAD`	Leaf area index decline rate parameter *(cols. 75-82)* In several plants, leaf area declines due to leaf senescence as the plant approaches physiological maturity. In most cases, leaf senescence begins with yellowing of the older (lower) leaves and proceeds upward until, in crops like corn, wheat, and soybeans, all leaves senesce and the plant dies. In many grain crops, leaf area index declines linearly with time after grain filling begins. Nutrients and carbohydrates in the senescing leaves are often translocated into the grain. In EPIC the plant parameter DLAI (described above) controls the point in the growing season when leaf area begins to decline. The plant parameter RLAD controls the rate of decline. If RLAD is set to 1.0, the rate of decline is linear. If RLAD < 1.0, the rate of decline is initially slow, then increases until all leaves are dead at maturity. If RLAD > 1.0, the rate of senescence is initially rapid, then slows as maturity approaches (Figure 18). In all cases, EPIC assumes that leaf area begins to decline when the fraction of the growing season equals DLAI, and the leaf area index approaches zero at maturity. *(Range: 0 to 10)*

Field	Variable name	Description
10	`RBMD`	Biomass-energy ratio decline rate parameter *(cols. 83-90)* This variable sets the biomass-energy (WA) decline rate during the growing season. This crop parameter functions like the RLAD above. It reduces the efficiency of conversion of intercepted photosynthetically active radiation to biomass due to production of high energy products like seeds and/or translocation of N from leaves to seeds. In most crops this rate is relatively constant during the vegetative stage of growth, when structural carbohydrates like cellulose are the principal products of growth. However, when grain crops begin to form seeds, the conversion of intercepted solar radiation into biomass begins to decline. That is, less dry matter is formed for each unit of absorbed solar radiation. In addition, as leaf area yellows and begins to senesce, the conversion efficiency declines still more. EPIC uses the crop parameter RBMD to reduce the rate of conversion of intercepted solar radiation to biomass as the crop approaches maturity (when the fraction of the growing season is greater than DLAI). Computationally, RBMD reduces WA like RLAD reduces leaf area index (see Figure 18). • RBMD = 1.0 gives a liner decline of WA. • RBMD < 1.0 gives an initially slow rate of decline, then the rate increases until all leaves are dead at maturity. • RBMD > 1.0 gives an initially rapid rate of decline, then the rate slows as maturity approaches. *(Range: 1 to 10)*
11	`ALT`	Aluminum tolerance index *(cols. 91-98)* Index of plant tolerance to aluminum saturation. *(Range: 1 (sensitive) to 5 (tolerant)*
12	`GSI`	Maximum Stomatal Conductance (m s^{-1}) *(cols. 99-106)* The crop parameter GSI is the maximum stomatal conductance at high solar radiation and low vapor pressure deficit. Korner et. al (1979) reported maximum stomatal conductance values for 246 species and cultivars (Koerner, Scheel, & Bauer, 1979).
13	`CAF`	Critical aeration factor *(cols. 107-114)* Fraction of soil porosity where poor aeration starts limiting plant growth. This is set at 0.85 for most crops, with rice being the major exception with a value of 1.0. *(Range: 0.1 to 1.0)*

Field	Variable name	Description
14	SDW	Seed weight (kg ha^{-1}) *(cols. 115-122)* The seed weight affect the starting crop biomass. A portion of the seed weight is allocated to the initial biomass. This is also used for transplanted crops.
15	HMX	Maximum crop height (m) *(cols. 123-130)* The greatest potential height the crop will reach.
16	RDMX	Maximum root depth (m) *(cols. 131-138)* The greatest depth to which the rooting system will penetrate. This affects soil moisture extraction.
17	WAC2	CO_2 Concentration / Resulting WA value *(cols. 139-146)* This is a split variable. In EPIC, radiation use efficiency is sensitive to atmospheric CO_2 concentration. WAC2 is an "S" curve parameter used to describe the effect of CO_2 concentration on the crop parameter WA. The value on the left of the decimal is a value of CO_2 concentration higher than ambient (i.e., 450 or 660 ul l^{-1}). The value on the right of the decimal is the corresponding value of WA. This elevated value of WA can be estimated from experimental data on short-term crop growth at elevated CO_2 levels. Calculate the ratio of crop growth rate at elevated CO_2 to crop growth at approximately 330 ul l^{-1} CO_2. Multiply that ratio by the value of WA at 330 ul l^{-1} to obtain the value on the right of the decimal. Typical values of the ratio for C4 plants are 1.1 to 1.2; 1.15 is used in CROPCOM.DAT for plants with the C4 photosynthetic pathway. Typical values of the ratio for C3 plants are 1.3 to 1.4; 1.35 is used in CROPCOM.DAT for these types of plants. (Kimball, 1983)
18	CNY	Fraction of nitrogen in yield (kg kg^{-1}) *(cols. 147-154)* This is the fraction of nitrogen in the yield compared to the entire plant and affects the amount of nitrogen removed from the field through the harvesting of the crop. This was estimated from Morrison's Feeds and Feeding and other data sources of plant nutrition. The percentage N in Morrison was adjusted to a dry weight by dividing by the fraction of dry matter to total yield. *(Range: 0.0 to 1.0)*

Field	Variable name	Description
19	CPY	Fraction of phosphorus in yield (kg kg^{-1}) *(cols. 155-162)* This is the fraction of phosphorus in the yield compared to the entire plant and affects the amount of phosphorus removed from the field through the harvesting of the crop. Estimated by same procedure as CNY above. *(Range: 0.0 to 1.0)*
20	CKY	Fraction of potassium in yield (kg kg^{-1}) *(cols. 163-170)* This is the fraction of potassium in the yield compared to the entire plant and affects the amount of potassium removed from the field through the harvesting of the crop. Estimated by same procedure as CNY above. *(Range: 0.0 to 1.0)*
21	WYSF	Lower limit of harvest index *(cols. 171-178)* Fraction between 0 and HI values that represents the lowest harvest index expected due to water stress. *(Range: 0 to 1)*
22	PST	Pest (insects and disease) factor *(cols. 179-186)* Fraction of yield remaining after damage. Usually set at 0.60. EPIC has an adjustment process that is a function of moisture, temperature and residue. This presently is a reasonable estimate, but future versions may include more detailed procedures. You may wish to adjust the parameter in geographic areas known to have large amounts of damage from pests. *(Range: 0 to 1)*
23	CSTS	Seed cost ($ kg^{-1}) *(cols. 187-194)* Cost of seed is used for economic analyses only.
24	PRYG	Price for grain yield ($ t^{-1}) *(cols. 195-202)* Price for grain yield is used for economic analyses only.
25	PRYF	Price for forage yield ($ t^{-1}) *(cols. 203-210)* Price for forage yield is used for economic analyses only.

Field	Variable name	Description
26	`WCY`	Fraction water in yield *(cols. 211-218)* The amount of water present in the yield at the time of harvest. The yields of most grain crops are reported at a standard grain water content; however, for some applications, grain dry weight is appropriate (WCY = 0). EPIC yield output is dry weight. *(Range: 0.0 to 1.0)*
27	`BN(1)`	Fraction on nitrogen in plant at emergence *(cols. 219-226)* Normal fraction of N in plant biomass at emergence. This parameter is based on research results published in the literature for each (or similar) plant.
28	`BN(2)`	Fraction on nitrogen in plant at 0.5 maturity *(cols. 227-234)* Normal fraction of N in plant biomass at mid growing season. This parameter is based on research results published in the literature for each (or similar) plant.
29	`BN(3)`	Fraction on nitrogen in plant at maturity *(cols. 235-242)* Normal fraction of N in plant biomass at maturity. This parameter is based on research results published in the literature for each (or similar) plant.
30	`BP(1)`	Fraction on phosphorus in plant at emergence *(cols. 243-250)* Normal fraction of P in plant biomass at emergence. This parameter is based on research results published in the literature for each (or similar) plant.
31	`BP(2)`	Fraction on phosphorus in plant at 0.5 maturity *(cols. 251-258)* Normal fraction of P in plant biomass at mid growing season. This parameter is based on research results published in the literature for each (or similar) plant.
32	`BP(3)`	Fraction on phosphorus in plant at maturity *(cols. 259-266)* Normal fraction of P in plant biomass at maturity. This parameter is based on research results published in the literature for each (or similar) plant.
33	`BK(1)`	Fraction on potassium in plant at emergence *(cols. 267-274)* Normal fraction of K in plant biomass at emergence. This parameter is based on research results published in the literature for each (or similar) plant.
34	`BK(2)`	Fraction on potassium in plant at 0.5 maturity *(cols. 275-282)* Normal fraction of K in plant biomass at mid growing season. This parameter is based on research results published in the literature for each (or similar) plant.

Field	Variable name	Description
35	`BK(3)`	Fraction on potassium in plant at maturity *(cols. 283-290)* Normal fraction of K in plant biomass at maturity. This parameter is based on research results published in the literature for each (or similar) plant.
36	`BWD(1)`	Wind erosion factor for standing live biomass *(cols. 291-298)* Based on the Manhattan wind erosion equations for each (or similar) plant.
37	`BWD(2)`	Wind erosion factor for standing dead biomass *(cols. 299-306)* Based on the Manhattan wind erosion equations for each (or similar) plant.
38	`BWD(3)`	Wind erosion factor for flat residue *(cols. 307-314)* Based on the Manhattan wind erosion equations for each (or similar) plant.
39	`IDC`	Crop category ID number *(cols. 315-322)* This ID number is used internally to identify the type of crop simulated by the model. Crop categories are: 1. Warm season annual legume. 2. Cold season annual legume. 3. Perennial legume. 4. Warm season annual. 5. Cold season annual. 6. Perennial. 7. Evergreen tree. 8. Deciduous tree. 9. Cotton. 10. Leguminous tree.
40	`FRST(1)`	First point on frost damage curve *(cols. 323-330)* The first of two points on the frost damage curve. Numbers before the decimal point are the minimum temperatures (°C) and numbers after the decimal point are the fraction of biomass lost each day the specified minimum temperature occurs. NOTE: 10.20 means 20 percent of the biomass is lost each day a temperature of -10 °C is reached. The negative sign on degrees is added by EPIC since no frost damage is assumed to occur above 0 °C. These two parameters should be based on a combination of research results and observation. Precise data for field application is subject to microclimate variation across the landscape. Current parameters are reasonable estimates; however, they are more likely to understate frost damage than to overstate frost damage.

Field	Variable name	Description
41	`FRST(2)`	Second point on frost damage curve *(cols. 331-338)* Second of two points on the frost damage curve. Numbers before the decimal point are the minimum temperatures (°C) and numbers after the decimal point are the fraction of biomass lost each day the specified minimum temperature occurs.
42	`WAVP`	Parm relating vapor pressure deficit to WA *(cols. 339-346)* In EPIC, radiation use efficiency (WA) is sensitive to vapor pressure deficit (VPD). As VPD increases, WA decreases. The crop parameter WAVP is the rate of the decline in WA per unit increase in VPD. The value of WAVP varies among species, but a value of 6 to 8 is suggested as an approximation for most crops.
43	`VPTH`	Threshold VPD (kPa) *(cols. 347-354)* In EPIC, leaf conductance is to VPD until VPD (calculated hourly) exceeds the threshold value, VPTH (usually 0.5 to 1.0 kPa).
44	`VPD2`	VPD value (kPa) *(cols. 355-362)* In EPIC, leaf conductance declines linearly as VPD increases above VPTH. VPD2 is a double parameter in which the number on the left of the decimal point is some value of VPD above VPTH (e.g., 4.0), and the number on the right of the decimal point is the corresponding fraction of the maximum leaf conductance at the value of VPD (e.g., 0.7). insensitive
45	`RWPC(1)`	Fraction of root weight at emergence *(cols. 363-370)* This is one of the partitioning parameters to split biomass between above ground and roots. RWPC(1) is the partitioning fraction at emergence and RWPC(2) is partitioning fraction at maturity. Between those two points there is a linear interpolation of the partitioning fraction relative to accumulative heat units. *(Range: 0.0 to 1.0)*
46	`RWPC(2)`	Fraction of root weight at maturity *(cols. 371-378)* This is one of the partitioning parameters to split biomass between above ground and roots. RWPC(1) is the partitioning fraction at emergence and RWPC(2) is partitioning fraction at maturity. Between those two points there is a linear interpolation of the partitioning fraction relative to accumulative heat units. *(Range: 0.0 to 1.0)*

Field	Variable name	Description
47	GMHU	Heat units required for germination (°C) *(cols. 379-386)* This is the amount of thermal units required by the seed to germinate. This delays germination from the planting date or the date at which the temperature of soil layer 2 exceeds TBSC. *(Range: 0.0 to 500)*
48	PPLP(1)	Plant Population – Leaf area index curve *(cols. 387-394)* First of two points on population curve. Plant Population for crops, grass etc., except trees or plants requiring more than 1 m^2 per plant. The number to the left of the decimal is the number of plants (plants m^{-2}) and the number to right is the fraction of maximum leaf area at that population. NOTE: if the crop is trees, the population is expressed as plants per hectare and the second plant population point is placed in the PPLP(1) position and the first point placed in the PPLP(2) position. Consequently, in the case of trees the first point should be the higher population. If entering plants m^{-2} then PPLP(1) < PPLP(2) If entering plants ha^{-1} then PPLP(1) > PPLP(2)
49	PPLP(2)	Plant Population – Leaf area index curve *(cols. 395-402)* Second of two points on population curve. The number to the left of the decimal is the number of plants (plants m^{-2}) and the number to right is the fraction of maximum leaf area at that population. NOTE: if the crop is trees, the population is expressed as plants per hectare and the second plant population point is placed in the PPLP(1) position and the first point placed in the PPLP(2) position. Consequently, in the case of trees the first point should be the higher population. If entering plants m^{-2} then PPLP(1) < PPLP(2) If entering plants ha^{-1} then PPLP(1) > PPLP(2) For example, corn can have PPLP(1) = 30.43 and PPLP(2) = 50.71. This means at 30 plants m^{-2} 43% of maximum leaf area can be attained. This is also the 1st point on the population curve. PPLP(2) means at 50 plants m^{-2} 71% of maximum leaf area can be attained. This is the 2nd point on population curve for corn production. Since PPLP(1) is less than PPLP(2), it shows the population density of a crop other than trees. However, for pine tree, PPLP(1) = 1000.95 and PPLP(2) = 100.10. While the numbers before and after decimal have the same explanations as given for corn, it indicates the population density is for a tree (hence in plants ha^{-1}) because here PPLP(1) is greater than PPLP(2).

Field	Variable name	Description
50	`STX(1)`	Salinity effect on yield ((t ha^{-1})/(mmho cm^{-1})) *(cols. 403-410)* This is the yield decrease per increase in salinity.
51	`STX(2)`	Salinity threshold (mmho/cm) *(cols. 411-418)* The threshold points at which any increase in salinity will cause a decrease in yield.
52	`BLG(1)`	Lignin fraction in plant at 0.5 maturity *(cols. 419-426)* Fraction of lignin when the plant reaches 0.5 maturity.
53	`BLG(2)`	Lignin fraction in plant at full maturity *(cols. 427-434)* Fraction of lignin when the plant reaches full maturity.
54	`WUB`	Water use conversion to biomass (t/mm) *(cols. 435-442)* The amount of biomass produced per unit of water used by the plant. This value is used if the experimental water use – biomass conversion method is selected in the EPPICCONT file (ICG > 0).
55	`FTO`	Fraction turnout for cotton *(cols. 443-450)* OR Leaf fall for deciduous trees The fraction of lint present in the total plant material (lint + seed + trash (leaf and stem particles)) harvested. This value is higher for cotton which is picked compared to stripped because less trash is collected along with the lint and seed as it is harvested. A typical value for picker cotton is 0.38 and 0.27 for stripper cotton. This variable is valid only for cotton and the yield is reported in the field of grain yield (YLDG). In the calculation, FTO is used as: YLDG=YLDG+FTO*YY Where YY is the yield calculated as for any other crop considering the standing live biomass, the harvest index, the harvest efficiency, and pest damage. Turnout fraction = (lint weight / (seed weight + lint weight + trash weight))

Field	Variable name	Description
55 (cont.)	`FTO` `(cont.)`	For DECIDUOUS TREES, FTO represents the percent of biomass lost to leaf fall. Usually set FTO to 0.05 for deciduous trees. *(Range: 0.01 to 0.90)*
56	`FLT`	Fraction lint for cotton *(cols. 451-458)* The fraction of lint present in the total seed cotton (seed + lint) harvested. This variable differs from FTO in that trash is not included in the total harvested weight. Lint fraction cannot be less than turnout fraction. This variable is valid only for cotton and the yield is reported in the field of forage yield (YLDF). In the calculation, FTL is used as: YLDF=YLDF+YLDG*(1.0/FLT-1.0) Where YLDG is the yield calculated as described for FTO. Lint fraction = (lint weight / (seed weight + lint weight)) *(Range: 0.01 to 1.00)*
57	`CCEM`	Carbon emission for seeding (kg kg^{-1}) *(cols. 459-466)*
58	`FLSL`	Leaf weight at DLAI (fraction) *(cols. 467-474)* It is the ratio between weight of leaves weight and weight of standing live biomass. *(Range: 0.01 to 1.00)*

Figure 17. Plant leaf area development based on DLAP(1) and DLAP(2).

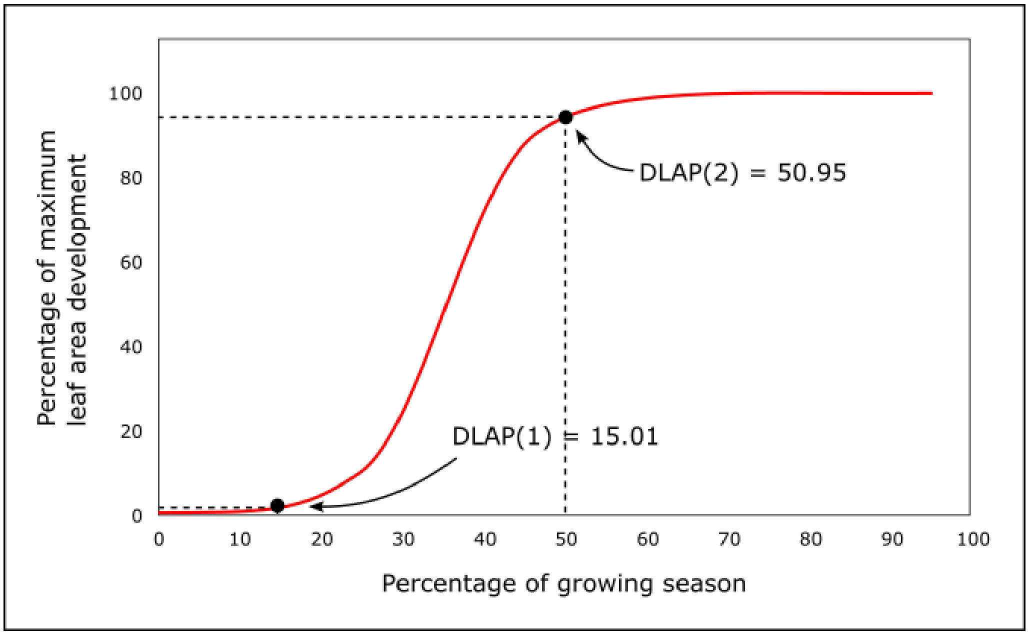


Figure 18. Plant leaf area development based on DLAI and RLAD.

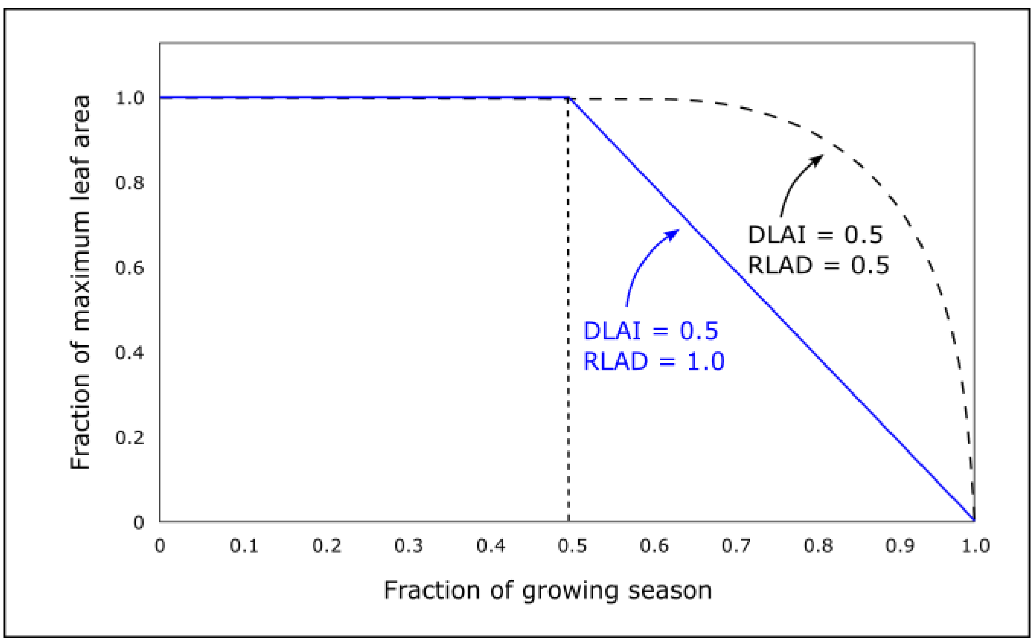


Figure 19. Illustration of LAI - plant population curve.

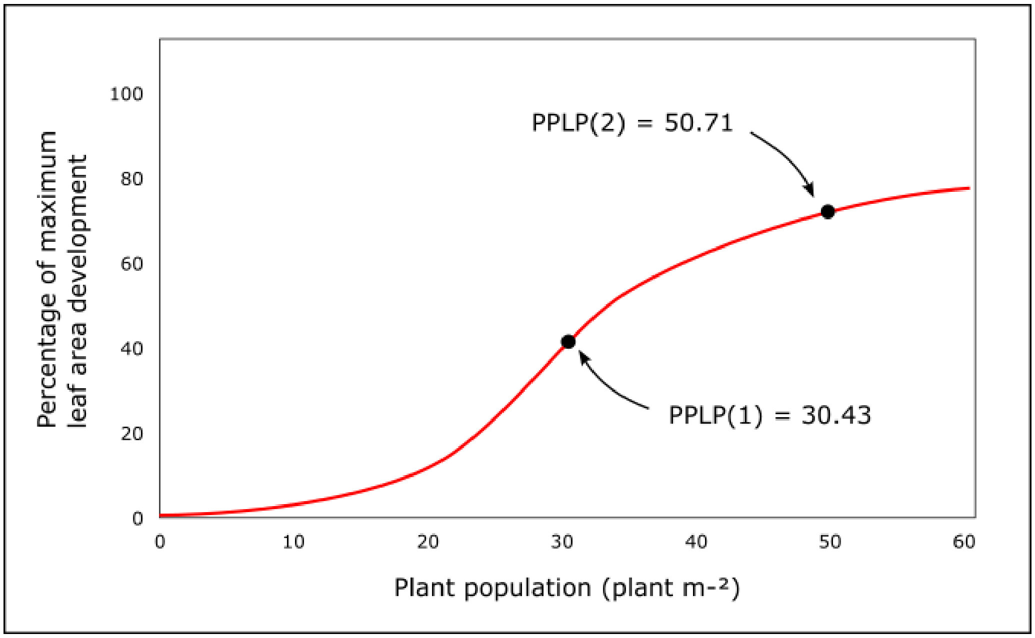


Figure 20. Example of CROPCOM.DAT file with the list of plants available for simulation in EPIC1102.

CROP		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
#	NAME	WA	HI	TOP	TBS	DMLA	DLAI	DLAP1	DLAP2	RLAD	RBMD	ALT	GSI	CAF	SDW	HMX	RDMX	WAC2	CNY	CPY	CKY
1	SOYB	25.00	0.30	25.00	10.00	5.00	0.90	15.05	50.95	0.10	1.00	3.00	0.0070	0.85	35.00	0.80	2.00	660.34	0.0699	0.0077	0.0196
2	CORN	40.00	0.50	25.00	8.00	6.00	0.80	10.10	50.95	1.00	1.	3.00	0.0070	0.85	20.00	2.00	2.00	660.45	.013	0.0025	0.0032
3	GRSG	37.00	0.50	27.50	10.00	5.50	0.80	15.01	60.95	0.50	0.50	2.00	0.0070	0.85	5.00	1.40	2.00	660.36	0.0199	0.0032	0.0039
4	COTS	25.00	0.60	27.50	12.50	6.00	0.95	15.01	50.95	0.50	0.50	3.00	0.0200	0.85	25.00	1.00	2.20	660.30	0.0140	0.0020	0.0140
5	COTP	25.00	0.40	27.50	12.50	6.00	0.95	15.01	50.95	0.50	0.50	3.00	0.0200	0.85	25.00	1.00	2.20	660.30	0.0190	0.0029	0.0140
6	PNUT	30.00	0.00	25.00	9.00	5.00	0.85	15.01	50.95	1.00	0.50	4.00	0.0100	0.85	30.00	0.50	2.00	660.25	0.0650	0.0090	0.0060
7	SUNF	49.00	0.30	25.00	10.	5.00	0.55	15.01	50.95	1.00	2.00	3.00	0.0070	0.85	8.00	2.50	2.20	660.66	0.0287	0.0056	0.0071
8	CSUN	60.00	0.25	25.00	6.00	5.00	0.55	15.01	50.95	1.00	2.00	3.00	0.0070	0.85	8.00	2.50	2.20	660.81	0.0287	0.0056	0.0071
9	FALW	30.	0.40	125.	100.	0.00	0.55	15.01	50.95	1.00	1.00	3.00	0.0130	0.85	0.01	2.00	10.	660.35	0.0280	0.0060	0.0070
10	WWHT	35.00	0.45	15.00	0.00	6.00	0.60	15.01	50.95	1.00	1.00	2.00	0.0070	0.85	90.00	1.00	1.50	660.47	0.0249	0.0033	0.0042
11	SWHT	35.00	0.45	20.	5.0	6.00	0.60	15.01	50.95	1.00	1.00	2.00	0.0070	0.85	90.00	1.00	2.00	660.41	0.0303	0.0038	0.0039
12	CSWH	35.00	0.42	15.00	0.00	5.00	0.60	15.01	45.95	1.00	1.00	2.00	0.0070	0.85	90.00	1.00	2.00	660.47	0.0303	0.0038	0.0039
13	DWHT	30.00	0.40	15.00	0.00	5.00	0.60	15.01	50.95	1.00	1.00	2.00	0.0070	0.85	90.00	1.00	2.00	660.41	0.0263	0.0057	0.0048
14	BARL	30.00	0.40	15.00	0.00	6.00	0.80	15.01	50.95	1.00	1.00	2.00	0.0060	0.85	90.00	1.00	2.00	660.45	0.0236	0.0029	0.0060
15	CBAR	35.00	0.42	15.00	0.00	3.50	0.60	20.10	49.95	1.00	1.00	2.00	0.0070	0.85	90.00	1.20	2.00	660.47	0.0236	0.0029	0.0050
16	OATS	35.00	0.42	15.00	0.00	6.00	0.80	15.01	50.95	1.00	1.00	2.00	0.0070	0.85	90.00	1.00	2.00	660.47	0.0316	0.0057	0.0047
17	COAT	35.00	0.42	15.00	0.00	5.00	0.60	15.01	45.95	1.00	1.00	2.00	0.0070	0.85	90.00	1.20	2.00	660.47	0.0316	0.0057	0.0047
18	RICE	25.00	.2	25.00	10.00	6.00	0.80	15.01	50.95	0.50	0.50	3.00	0.0080	1.00	50.00	0.80	2.00	660.34	0.0136	0.0013	0.0013
19	RYE	35.00	0.40	12.50	0.00	6.00	0.80	15.01	50.95	1.00	1.00	2.00	0.0060	0.85	90.00	1.00	2.00	660.47	0.0284	0.0042	0.0030
20	WPEA	20.00	0.55	14.00	1.00	4.00	0.90	15.02	50.95	1.00	0.50	2.00	0.0100	0.85	140.00	0.80	2.00	660.27	0.0412	0.0055	0.0114
21	LEN1	20.00	0.55	14.00	1.00	5.00	0.90	15.02	50.95	1.00	0.50	3.00	0.0100	0.90	100.00	0.55	2.00	660.27	0.0506	0.0051	0.0102
22	LENT	20.00	0.55	14.00	1.00	4.00	0.90	15.02	50.95	1.00	0.50	3.00	0.0100	0.90	100.00	0.55	2.00	660.27	0.0506	0.0051	0.0102
23	CANA	34.00	0.25	21.00	5.00	3.40	0.49	15.02	45.95	0.20	0.30	3.00	0.0078	0.90	100.00	1.30	1.40	660.46	0.0360	0.0084	0.0380
24	CANP	34.00	0.23	21.00	5.00	3.50	0.50	15.02	45.95	0.20	0.30	3.00	0.0078	0.90	100.00	0.90	0.90	660.46	0.0360	0.0084	0.0380
25	FLAX	25.00	0.54	22.50	5.00	2.50	0.90	15.02	50.95	1.00	0.50	3.00	0.0078	0.90	100.00	0.55	2.00	660.34	0.0409	0.0055	0.0084
26	FPEA	25.00	0.45	15.00	1.00	5.00	0.75	15.01	50.95	2.00	2.00	2.00	0.0070	0.85	35.00	1.20	2.00	660.34	0.0412	0.0055	0.0114
27	MUNG	25.00	0.31	25.00	10.00	5.00	0.90	15.01	50.95	2.00	10.00	3.00	0.0078	0.85	35.00	1.50	2.00	660.34	0.0420	0.0040	0.0137
28	SESB	50.00	0.31	25.00	10.00	5.00	0.90	15.01	50.95	2.00	10.00	3.00	0.0078	0.85	35.00	1.50	2.00	660.67	0.0419	0.0039	0.0110
29	CSIL	40.00	0.50	25.00	8.00	6.25	0.90	10.15	50.95	0.90	1.00	3.00	0.0070	0.85	20.00	3.10	1.50	660.45	0.0168	0.0023	0.0032
30	SGHY	35.00	0.50	27.50	10.00	5.00	0.80	15.01	50.95	0.50	0.50	2.00	0.0070	0.85	90.00	2.00	2.00	660.40	0.0199	0.0032	0.0039
31	ALFA	20.00	0.02	25.00	1.00	2.60	0.90	15.01	50.95	0.50	0.50	3.00	0.0100	0.85	15.00	1.25	2.00	660.27	0.0601	0.0066	0.0074
32	CLVA	15.	0.02	15.	0.	5.00	0.60	15.01	50.95	2.00	10.00	2.00	0.0070	0.99	35.00	1.20	2.00	660.34	0.0567	0.0040	0.0180
33	CLVR	25.00	0.02	25.00	1.00	5.00	0.75	15.01	50.95	2.00	10.00	2.00	0.0070	0.85	35.00	1.20	2.00	660.34	0.0597	0.0040	0.0180
34	CLVS	25.00	0.02	25.00	1.00	5.00	0.75	15.01	50.95	2.00	10.00	2.00	0.0070	0.75	35.00	1.20	2.00	660.34	0.0649	0.0040	0.0180
35	TIMO	35.00	0.02	25.00	8.00	11.00	0.85	15.01	50.95	2.00	1.00	2.00	0.0070	0.85	5.00	0.80	2.00	660.47	0.0234	0.0033	0.0150

CROPCOM.DAT - Notepad

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
WSYF	PST	COSD	PRYG	PRYF	WCY	BN1	BN2	BN3	BP1	BP2	BP3	BK1	BK2	BK3	BW1	BW2	BW3	IDC	FRST1	FRST2
0.23	0.60	0.63	198.08	100.00	0.13	0.0524	0.0265	0.0258	0.0074	0.0037	0.0035	0.0120	0.0100	0.0090	1.266	0.633	0.729	1.	5.15	15.95
0.40	0.60	3.45	103.16	80.22	0.15	0.0440	.015	.01	0.0062	0.0023	0.0018	0.0150	0.0120	0.0090	0.433	0.433	0.213	4.	5.15	15.95
0.35	0.60	3.66	92.83	75.00	0.13	0.0440	0.0164	0.0128	0.0060	0.0022	0.0018	0.0270	0.0180	0.0130	0.657	0.657	0.320	4.	5.15	15.95
0.30	0.60	2.82	1212.75	116.87	0.01	0.0580	0.0190	0.0177	0.0081	0.0027	0.0025	0.0300	0.0220	0.0150	1.138	0.603	0.332	9.	5.15	15.95
0.30	0.60	2.82	1212.75	116.87	0.01	0.0580	0.0190	0.0177	0.0081	0.0027	0.0025	0.0300	0.0220	0.0150	1.138	0.603	0.332	9.	5.15	15.95
0.30	0.60	1.80	498.33	551.00	0.06	0.0329	0.0167	0.0162	0.0039	0.0020	0.0019	0.0300	0.0200	0.0090	1.266	0.633	0.729	1.	5.15	15.95
0.27	0.60	8.71	271.22	5.00	0.06	0.0500	0.0230	0.0146	0.0063	0.0029	0.0023	0.0290	0.0200	0.0100	3.390	3.390	1.610	4.	5.15	15.95
0.22	0.60	8.71	271.22	5.00	0.06	0.0500	0.0230	0.0146	0.0063	0.0029	0.0023	0.0290	0.0200	0.0100	3.390	3.390	1.610	4.	5.15	15.95
0.30	0.60	4.41	190.00	5.00	0.06	0.0500	0.0230	0.0150	0.0060	0.0030	0.0020	0.0290	0.0200	0.0100	1.138	0.603	0.332	4.	5.15	15.95
0.21	0.60	0.26	153.62	20.00	0.12	0.0600	0.0230	0.0134	0.0084	0.0032	0.0019	0.0230	0.0200	0.0170	3.390	3.390	1.610	5.	5.01	15.10
0.21	0.60	0.22	157.66	20.00	0.12	0.0663	0.0250	0.0148	0.0084	0.0032	0.0019	0.0230	0.0200	0.0170	3.390	3.390	1.610	5.	5.01	15.10
0.21	0.60	0.26	157.66	20.00	0.12	0.0663	0.0250	0.0148	0.0084	0.0032	0.0019	0.0230	0.0200	0.0170	3.390	3.390	1.610	5.	5.01	15.10
0.20	0.60	0.26	154.35	20.00	0.12	0.0518	0.0199	0.0116	0.0089	0.0034	0.0020	0.0230	0.0200	0.0170	3.390	3.390	1.610	5.	5.01	15.10
0.21	0.60	0.27	122.19	20.00	0.12	0.0590	0.0220	0.0131	0.0057	0.0022	0.0013	0.0160	0.0160	0.0150	3.390	3.390	1.610	5.	5.01	15.10
0.21	0.60	0.27	122.19	20.00	0.12	0.0590	0.0220	0.0131	0.0057	0.0022	0.0013	0.0160	0.0160	0.0150	3.390	3.390	1.610	5.	5.01	15.10
0.21	0.60	0.03	124.03	20.00	0.10	0.0580	0.0224	0.0130	0.0053	0.0020	0.0012	0.0280	0.0200	0.0120	3.390	3.390	1.610	5.	5.01	15.10
0.21	0.60	0.03	124.03	20.00	0.10	0.0580	0.0224	0.0130	0.0053	0.0020	0.0012	0.0280	0.0200	0.0120	3.390	3.390	1.610	5.	5.01	15.10
0.25	0.60	0.85	86.88	20.00	0.14	0.0500	0.0200	0.0100	0.0060	0.0030	0.0018	0.0250	0.0150	0.0080	3.390	3.390	1.610	4.	5.05	15.95
0.20	0.60	2.38	98.04	75.00	0.12	0.0560	0.0215	0.0125	0.0066	0.0025	0.0015	0.0180	0.0150	0.0120	3.390	3.390	1.610	5.	5.01	15.10
0.38	0.60	0.69	24.00	75.00	0.12	0.0400	0.0260	0.0232	0.0070	0.0040	0.0030	0.0140	0.0130	0.0120	3.390	3.390	1.610	2.	5.01	15.10
0.38	0.60	22.40	100.00	5.00	0.12	0.0440	0.0164	0.0128	0.0074	0.0037	0.0023	0.0140	0.0130	0.0120	1.266	0.633	0.729	1.	5.01	15.10
0.38	0.60	22.40	100.00	5.00	0.12	0.0440	0.0164	0.0128	0.0074	0.0037	0.0023	0.0140	0.0130	0.0120	1.266	0.633	0.729	2.	5.01	15.10
0.21	0.60	10.75	147.74	5.00	0.12	0.0440	0.0164	0.0128	0.0074	0.0037	0.0023	0.0440	0.0160	0.0130	1.266	0.633	0.729	4.	5.05	15.10
0.16	0.60	10.75	147.74	5.00	0.12	0.0440	0.0182	0.0164	0.0073	0.0037	0.0023	0.0440	0.0160	0.0130	1.266	0.633	0.729	4.	5.05	15.10
0.27	0.60	0.31	143.32	5.00	0.12	0.0482	0.0294	0.0263	0.0049	0.0024	0.0023	0.0200	0.0130	0.0070	1.266	0.633	0.729	2.	5.05	15.10
0.34	0.60	0.74	24.00	5.00	0.12	0.0515	0.0335	0.0296	0.0033	0.0019	0.0014	0.0140	0.0130	0.0120	3.390	3.390	1.610	2.	5.01	15.10
0.23	0.60	0.74	370.00	5.00	0.13	0.0326	0.0165	0.0161	0.0044	0.0022	0.0021	0.0140	0.0130	0.0120	1.266	0.633	0.729	1.	5.05	15.95
0.23	0.60	0.74	370.00	5.00	0.13	0.0500	0.0200	0.0150	0.0074	0.0037	0.0035	0.0140	0.0140	0.0130	1.266	0.633	0.729	1.	5.05	15.95
0.25	0.60	3.45	0.00	31.50	0.70	0.0440	0.0160	0.0128	0.0062	0.0023	0.0018	0.0150	0.0120	0.0090	1.266	0.633	0.729	4.	5.01	15.95
0.45	0.60	3.66	0.00	33.08	0.13	0.0440	0.0164	0.0128	0.0060	0.0022	0.0018	0.1500	0.1500	0.1500	3.390	3.390	0.320	4.	5.05	15.95
0.01	0.60	3.64	77.00	172.86	0.12	0.0500	0.0283	0.0240	0.0071	0.0024	0.0019	0.0231	0.0189	0.0178	3.390	3.390	3.390	3.	5.01	15.10
0.01	0.60	2.13	24.00	5.00	0.08	0.0600	0.0280	0.0240	0.0060	0.0030	0.0025	0.0220	0.0200	0.0180	3.390	3.390	3.390	3.	5.01	15.10
0.01	0.60	3.15	24.00	5.00	0.12	0.0650	0.0280	0.0243	0.0060	0.0029	0.0024	0.0220	0.0200	0.0180	3.390	3.390	3.390	2.	5.01	15.10
0.01	0.60	2.13	24.00	5.00	0.08	0.0650	0.0242	0.0200	0.0060	0.0029	0.0024	0.0300	0.0230	0.0180	3.390	3.390	3.390	2.	5.01	15.10
0.01	0.60	2.54	20.00	72.76	0.10	0.0314	0.0130	0.0103	0.0038	0.0025	0.0019	0.0180	0.0160	0.0150	3.390	3.390	3.390	6.	5.05	15.95

CROPCOM.DAT - Notepad

42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	
WAVP	VPTH	VPD2	RWPC1	RWPC2	GMHU	PPLP1	PPLP2	STX1	STX2	BLG1	BLG2	WUB	FTO	FLT	CCEM	FLSL	
5.00	0.50	4.75	0.40	0.20	100.00	30.43	50.71	0.20	5.00	0.01	0.10	0.00	0.00	0.00	15.	0.0	SOYBEANS
8.00	0.50	4.75	0.40	0.20	100.00	4.47	6.77	0.12	1.70	0.01	0.10	10.2	0.00	0.00	6.	0.0	CORN
7.00	0.50	4.75	0.40	0.20	100.00	3.20	10.90	0.20	4.80	0.01	0.10	0.00	0.00	0.00	10.	0.0	GRAIN SORGHUM
3.00	1.00	4.30	0.40	0.20	100.00	3.20	10.90	0.05	7.70	0.01	0.10	0.00	0.27	0.38	7.	0.0	STRIPPER COTTON
3.00	1.00	4.30	0.40	0.20	100.00	3.20	10.90	0.05	7.70	0.01	0.10	0.00	0.38	0.38	7.	0.0	PICKER COTTON
4.00	0.50	4.75	0.40	0.60	100.00	3.10	10.90	0.29	3.20	0.01	0.10	0.00	0.00	0.00	15.	0.0	PEANUTS
7.00	0.50	4.75	0.40	0.20	100.00	2.6	6.95	0.05	7.70	0.01	0.10	0.00	0.00	0.00	3.	0.0	SUNFLOWERS
7.00	0.50	4.75	0.40	0.20	100.00	2.63	6.99	0.05	7.70	0.01	0.10	0.00	0.00	0.00	3.	0.0	CAN SUNFLOWERS
7.00	0.50	4.75	0.40	0.20	0.00	1.10	4.90	0.05	7.70	0.01	0.10	0.00	0.00	0.00	0.	0.0	FALLOW
6.	0.50	4.75	0.40	0.20	100.00	125.60	250.95	0.07	6.00	0.01	0.10	0.00	0.00	0.00	150.	0.0	WINTER WHEAT
10.	0.50	4.75	0.40	0.20	45.00	125.60	250.95	0.07	6.00	0.01	0.10	0.00	0.00	0.00	150.	0.0	SPRING WHEAT
8.00	0.50	4.75	0.40	0.20	100.00	125.60	250.95	0.07	6.00	0.01	0.10	0.00	0.00	0.00	150.	0.0	CAN SPRING WHEAT
7.00	0.50	4.75	0.40	0.20	100.00	125.60	250.95	0.07	6.00	0.01	0.10	0.00	0.00	0.00	150.	0.0	DURAM WHEAT
7.00	0.50	4.75	0.40	0.20	100.00	125.60	250.95	0.05	8.00	0.01	0.10	0.00	0.00	0.00	150.	0.0	BARLEY
8.00	0.50	4.75	0.40	0.20	100.00	125.60	250.95	0.05	8.00	0.01	0.10	0.00	0.00	0.00	150.	0.0	CAN BARLEY
7.00	0.50	4.75	0.40	0.20	100.00	125.60	250.95	0.07	8.00	0.01	0.10	0.00	0.00	0.00	150.	0.0	OATS
8.00	0.50	4.75	0.40	0.20	100.00	125.60	250.95	0.07	8.00	0.01	0.10	0.00	0.00	0.00	150.	0.0	CAN OATS
5.00	0.50	4.75	0.40	0.20	100.00	125.60	250.95	0.12	3.00	0.01	0.10	0.00	0.00	0.00	150.	0.0	RICE
7.00	0.50	4.75	0.40	0.20	100.00	125.60	250.95	0.08	5.60	0.01	0.10	0.00	0.00	0.00	150.	0.0	RYE
4.00	0.50	4.75	0.40	0.20	100.00	20.20	100.90	0.10	2.50	0.01	0.10	0.00	0.00	0.00	70.	0.0	WINTER PEAS
4.00	0.50	4.75	0.40	0.20	100.00	20.20	100.90	0.10	2.50	0.01	0.10	0.00	0.00	0.00		0.0	
4.00	0.50	4.75	0.40	0.20	100.00	20.20	100.90	0.10	2.50	0.01	0.10	0.00	0.00	0.00	70.	0.0	LENTILS
10.00	0.50	4.75	0.40	0.20	100.00	20.20	100.90	0.10	2.50	0.01	0.10	0.00	0.00	0.00	70.	0.0	CANOLA-ARGENTINE
10.00	0.50	4.75	0.40	0.20	100.00	20.20	100.90	0.10	2.50	0.01	0.10	0.00	0.00	0.00	70.	0.0	CANOLA-POLISH
10.00	1.00	4.75	0.40	0.20	100.00	20.20	100.90	0.10	2.50	0.01	0.10	0.00	0.00	0.00	70.	0.0	FLAX
10.00	1.00	4.75	0.40	0.20	100.00	20.20	100.90	0.10	2.50	0.01	0.10	0.00	0.00	0.00	70.	0.0	FIELD PEAS
10.00	1.00	4.75	0.40	0.20	100.00	20.20	100.90	0.10	2.50	0.01	0.10	0.00	0.00	0.00	70.	0.0	SUMMER MUNG
10.00	1.00	4.75	0.40	0.20	100.00	20.20	100.90	0.10	2.50	0.01	0.10	0.00	0.00	0.00	70.	0.0	SESBANIA
8.00	0.50	4.75	0.40	0.20	100.00	4.47	6.90	0.12	1.70	0.01	0.10	0.00	0.00	0.00	6.	0.0	CORN SILAGE
7.00	0.50	4.75	0.40	0.20	100.00	5.43	15.79	0.20	4.80	0.01	0.10	0.00	0.00	0.00	10.	0.0	SORGHUM HAY
4.00	0.50	4.75	0.40	0.20	100.00	22.50	40.71	0.07	2.00	0.01	0.10	0.00	0.00	0.00	35.	0.0	ALFALFA
10.00	1.00	4.75	0.40	0.20	100.00	20.20	100.90	0.12	1.50	0.01	0.10	0.00	0.00	0.00	35.	0.0	CLOVER ALSIKE
10.00	1.00	4.75	0.40	0.20	100.00	22.50	40.71	0.12	1.50	0.01	0.10	0.00	0.00	0.00	35.	0.0	RED CLOVER
10.00	1.00	4.75	0.40	0.20	100.00	22.50	40.71	0.12	1.50	0.01	0.10	0.00	0.00	0.00	35.	0.0	SWEET CLOVER
8.00	0.50	4.75	0.40	0.20	100.00	22.50	40.71	0.09	2.00	0.01	0.10	0.00	0.00	0.00	35.	0.0	TIMOTHY

NOTE: The last column with the plant name is just for reference and it is not used by the model.

EPIC fertilizer list file (FERTCOM.DAT)

File format: different formats are used to read fertilizer list file.

Line 1 – 2: headers not used in the simulation

Line 3 – n: fixed format with

- *one space*
- *one integer with four characters*
- *one space*
- *one string with eight characters*
- *11 fields of 8 characters each (floating)*

The EPIC fertilizer list file includes all the fertilizers that can be simulated by the model. Each fertilizer is characterized by nine parameters, which are all put in a single row in the EPIC fertilizer list file. New fertilizers can be added by the user. The fertilizer parameters already included in the EPIC fertilizer list file should not be modified without a knowledge of fertilizer characteristics. Elements included in the EPIC fertilizer list file are listed below.

Field	Variable name	Description
	`I`	Fertilizer ID *(cols. 2-5)* Unique number to identify the fertilizer. This number is used in the EPIC management file (JX(7) in OPSCCOM.DAT) to identify the fertilizer(s) that must be simulated.
	`FTNM`	Fertilizer name *(cols. 7-10)* A descriptive name that usually includes the N-P-K analysis or the type of manure.
1	`FN`	Mineral N fraction *(cols. 15-22)* Fraction of mineral nitrogen in the bulk fertilizer. *(Range: 0.0 to 1.0)*
2	`FP`	Mineral P fraction *(cols. 23-30)* Fraction of mineral phosphorus in the bulk fertilizer. This is the fraction of elemental phosphorus, not P_2O_5. To convert fraction of P_2O_5 to elemental phosphorus, multiply by 0.4366. *(Range: 0.0 to 1.0)*

Field	Variable name	Description
3	FK	Mineral K fraction *(cols. 31-38)* Fraction of mineral potassium in the bulk fertilizer. This is the fraction of elemental potassium, not K_2O. To convert fraction of K_2O to elemental potassium, multiply by 0.8301. *(Range: 0.0 to 1.0)*
4	FNO	Organic N fraction *(cols. 39-46)* This applies to organic fertilizers such as manures. This number must be obtained from an analysis test of the product. The amount is reported as a fraction. *(Range: 0.0 to 1.0)*
5	FPO	Organic P fraction *(cols. 47-54)* This applies to organic fertilizers such as manures. This number must be obtained from an analysis test of the product. The amount is reported as a fraction. *(Range: 0.0 to 1.0)*
6	FNH3	Ammonia N fraction (FMH3/FN) *(cols. 55-62)* The fraction of mineral nitrogen in the fertilizer that is in the ammonium (NH_4) form. *(Range: 0.0 to 1.0)*
7	FOC	Organic C fraction *(cols. 63-70)* Organic carbon = organic matter / 1.72 *(Range: 0.0 to 1.0)*
8	FSLT	Salt fraction *(cols. 71-78)* Amount of salt in fertilizer *(Range: 0.0 to 1.0)*
9	FCST	Cost of fertilizer *(cols. 79-86)* Used for economic analyses only.

Below are some examples of fertilizers.

Commercial Fertilizer, Example 1

If a producer applies a commercially blended fertilizer with an analysis of 20-15-10 (N-P-K) the parameters would be set as follows:

FN: 0.20
FP: 0.065
FK: 0.083
FNO: 0.00
FPO: 0.00
FNH3: 0.00

Commercial Fertilizer, Example 2

If a producer applies Ammonium nitrate (50% of N is in nitrate form and 50% is in ammonium form) with an analysis of 34-0-0 the parameters would be set as follows:

FN: 0.34
FP: 0.00
FK: 0.00
FNO: 0.00
FPO: 0.00
FNH3: 0.50

Manure Fertilizer, Example 1

A producer applies 1200 pounds of bulk manure that includes 24 pounds of nitrogen which is broken into 6 pounds of mineral nitrogen and 18 pounds of organic nitrogen. The mineral nitrogen includes 5 pounds of ammonia-N and 1 pound of nitrate-N. The bulk manure also includes 30 pounds of potassium and 20 pounds of phosphorus of which 8 pounds is organic phosphorus.

Summary of components

1200 lbs bulk manure fertilizer

- 24 lbs nitrogen
    - 6 lbs mineral nitrogen
        - 5 lbs ammonia-N
        - 1 lb nitrate-N
    - 18 lbs organic nitrogen
- 20 lbs P
    - 8 lbs organic P
    - 12 lbs mineral P
- 30 lbs K

The parameters would be set as follows:

FN: 0.005 (6 lbs mineral N/1200 lbs total fertilizer)
FP: 0.01 (12 lbs P/1200 lbs total fertilizer)
FK: 0.025 (30 lbs K/1200 lbs total fertilizer)
FNO: 0.015 (18 lbs organic N/1200 lbs total fertilizer)
FPO: 0.007 (8 lbs P/1200 lbs total fertilizer)
FNH3: 0.83 (5 lbs ammonia-N/6 lbs mineral-N)

Figure 21. Example of FERTCOM.DAT file with the list of fertilizers available for simulation in EPIC1102.

FERTCOM.DAT - Notepad

File Edit Format View Help

|-Fertilizer|		1	2	3	4	5	6	7	8	9
#	Name	FN	FP	FK	FNO	FPO	FNH3	FOC	FSLT	FCST
1	RIESEL01	.0027	.0018	0.000	.0432	.0406	0.850	0.574	0.000	0.000
2	RIESEL02	.0051	.0014	0.000	.0287	.0372	0.820	0.346	0.000	0.000
3	RIESEL03	.0074	.0011	0.000	.0408	.0234	0.947	0.000	0.000	0.000
4	RIESEL04	.0048	.0011	0.000	.0268	.0265	0.851	0.000	0.000	0.000
5	B-FRESH2	0.024	0.008	0.000	0.010	0.004	0.990	0.350	0.000	0.000
6	D-FRESH	0.012	0.004	0.000	0.021	0.002	0.990	0.350	0.000	0.012
7	D-SO-MNU	0.002	0.007	0.000	0.022	0.004	0.972	0.420	0.000	0.000
8	D-1-LAGE	0.700	0.150	0.000	0.080	0.070	0.900	0.350	0.000	0.012
9	D-SO-LGN	0.049	0.082	0.000	0.648	0.221	0.972	0.350	0.000	0.012
10	D-LQ-LGN	0.566	0.090	0.000	0.102	0.242	0.987	0.350	0.000	0.012
11	goat-fsh	0.019	0.010	0.000	0.038	0.005	0.990	0.350	0.000	0.012
12	hog-frsh	0.021	0.016	0.000	0.040	0.007	0.990	0.350	0.000	0.012
13	horse-fs	0.013	0.006	0.000	0.023	0.003	0.990	0.350	0.000	0.012
14	P-DPIT-B	0.010	0.010	0.000	0.010	0.007	0.990	0.350	0.000	0.000
15	P-DPIT-L	0.010	0.010	0.000	0.010	0.007	0.990	0.350	0.000	0.012
16	P-FRSH-B	0.006	0.010	0.000	0.054	0.007	0.990	0.350	0.000	0.012
17	P-FRSH-D	0.003	0.005	0.000	0.027	0.002	0.990	0.350	0.000	0.012
18	P-FRSH-G	0.003	0.010	0.000	0.027	0.006	0.990	0.350	0.000	0.012
19	P-FRSH-L	0.005	0.010	0.000	0.045	0.007	0.990	0.350	0.000	0.012
20	P-FRSH-P	0.003	0.010	0.000	0.027	0.005	0.990	0.350	0.000	0.012
21	P-FRSH-T	0.006	0.010	0.000	0.054	0.007	0.990	0.350	0.000	0.012
22	P-LIQ-B	0.004	0.010	0.000	0.040	0.007	0.990	0.350	0.000	0.012
23	P-LIQ-L	0.004	0.010	0.000	0.040	0.007	0.990	0.350	0.000	0.012
24	P-MPIT-B	0.020	0.010	0.000	0.020	0.007	0.990	0.350	0.000	0.012
25	P-MPIT-L	0.020	0.010	0.000	0.020	0.007	0.990	0.350	0.000	0.012
26	sheep-fs	0.018	0.007	0.000	0.035	0.003	0.990	0.350	0.000	0.012
27	veal-fsh	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.100
28	RIESEL01	0.003	0.002	0.000	0.043	0.041	0.850	0.560	0.000	0.000
29	RIESEL02	0.005	0.001	0.000	0.029	0.037	0.820	0.350	0.000	0.000
30	RIESEL03	0.007	0.001	0.000	0.041	0.023	0.947	0.300	0.000	0.000
31	11-46-00	0.110	0.201	0.000	0.000	0.000	0.000	0.000	0.000	0.325
32	14-46-00	0.140	0.201	0.000	0.000	0.000	0.000	0.000	0.000	0.298
33	16-00-00	0.160	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.261
34	16-20-00	0.160	0.088	0.000	0.000	0.000	0.000	0.000	0.000	0.276
35	16-20-00	0.160	0.088	0.000	0.000	0.000	0.000	0.000	0.000	0.276

Ln 1, Col 1 100% Windows (CRLF) UTF-8

EPIC pesticide list file (PESTCOM.DAT)

File format: different formats are used to read plant list file.

Line 1 – 2: headers not used in the simulation

Line 3 – n: fixed format with

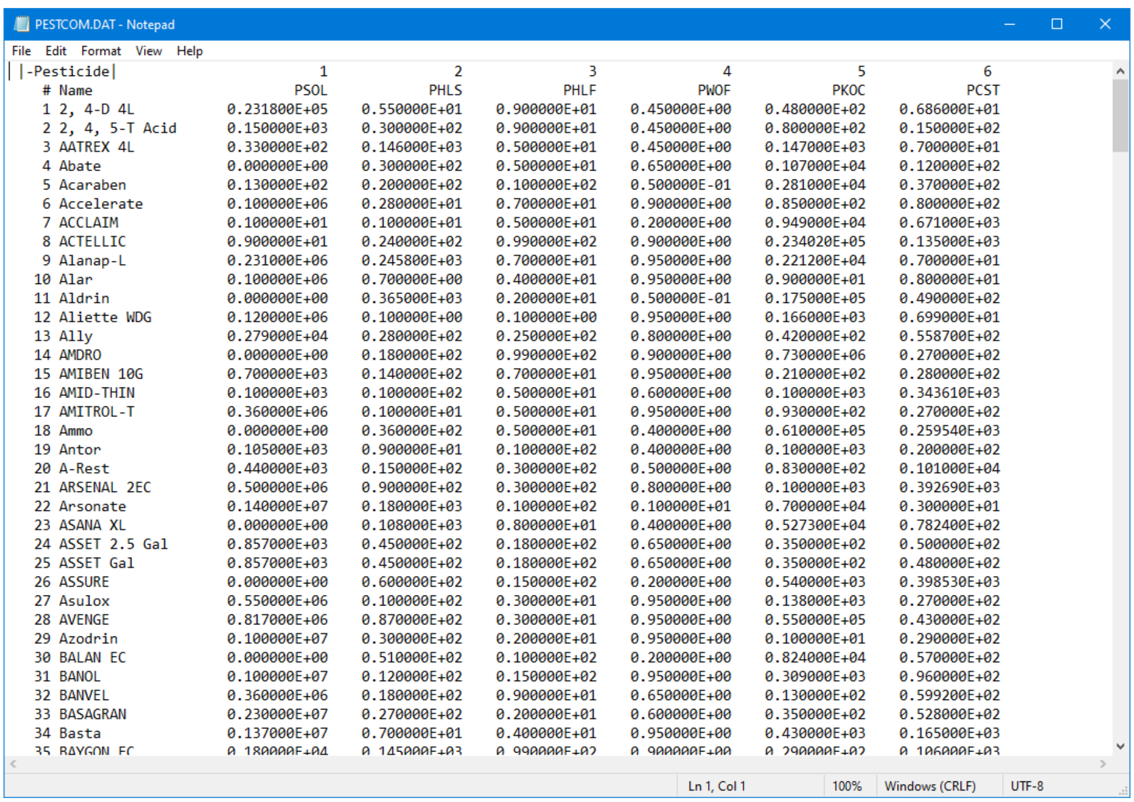
- *one integer with five characters*
- *one space*
- *one string with 16 characters*
- *7 fields of 16 characters each (exponential with 6 decimal digits)*

The EPIC pesticide list file includes all the pesticides that can be simulated by the model. Each pesticide is characterized by seven parameters, which are all arranged in a single row in the EPIC pesticide list file. New pesticides can be added by the user. The pesticide parameters already included in the EPIC pesticide list file should not be modified without a knowledge of pesticide characteristics. Elements included in the EPIC pesticide list file are listed below.

Field	Variable name	Description
	J1	Pesticide ID *(cols. 1-5)* Unique number to identify the pesticide. This number is used in the EPIC management file (JX(7) in OPSCCOM.DAT) to identify the pesticide(s) that must be simulated.
	PSTN	Pesticide name *(cols. 7-22)* Common or brand name of the pesticide.
1	PSOL	Pesticide solubility (ppm) *(cols. 23-34)* The amount of the pesticide product which can dissolve in water.
2	PHLS	Pesticide half-life in soil (days) *(cols. 35-42)* The time that it takes for the pesticide product concentration in the soil to be reduced by half.
3	PHLF	Pesticide half-life on foliage (days) *(cols. 43-50)* The time that it takes for the pesticide product concentration on the foliage to be reduced by half. Degradation occurs through microbial activity and/or sunlight.

Field	Variable name	Description
4	PWOF	Pesticide wash-off fraction *(cols. 51-58)* Percentage of the pesticide product that is applied to foliage that is washed off into the soil. *(Range: 0.0 to 1.0)*
5	PKOC	Pesticide organic C absorption coefficient *(cols. 59-68)* The amount of pesticide products attached to the soil divided by the amount of the pesticide product in solution, normalized by organic carbon % in the soil. Refer to Environmental Contaminant Toxicological Reviews.
6	PCST	Pesticide cost ($/KG) *(cols. 69-76)* Used for economic analyses only.
7	PCEM	Carbon emission / unit of pesticide (g/g) *(cols: 77-84)*

Figure 22. Example of PESTCOM.DAT file with the list of pesticides available for simulation in EPIC1102.




```
| |-Pesticide|                 1            2            3            4            5            6
   # Name                     PSOL         PHLS         PHLF         PWOF         PKOC         PCST
   1 2, 4-D 4L         0.231800E+05 0.550000E+01 0.900000E+01 0.450000E+00 0.480000E+02 0.686000E+01
   2 2, 4, 5-T Acid    0.150000E+03 0.300000E+02 0.900000E+01 0.450000E+00 0.800000E+02 0.150000E+02
   3 AATREX 4L         0.330000E+02 0.146000E+03 0.500000E+01 0.450000E+00 0.147000E+03 0.700000E+01
   4 Abate             0.000000E+00 0.300000E+02 0.500000E+01 0.650000E+00 0.107000E+04 0.120000E+02
   5 Acaraben          0.130000E+02 0.200000E+02 0.100000E+02 0.500000E-01 0.281000E+04 0.370000E+02
   6 Accelerate        0.100000E+06 0.280000E+01 0.700000E+01 0.900000E+00 0.850000E+02 0.800000E+02
   7 ACCLAIM           0.100000E+01 0.100000E+01 0.500000E+01 0.200000E+00 0.949000E+04 0.671000E+03
   8 ACTELLIC          0.900000E+01 0.240000E+02 0.990000E+02 0.900000E+00 0.234020E+05 0.135000E+03
   9 Alanap-L          0.231000E+06 0.245800E+03 0.700000E+01 0.950000E+00 0.221200E+04 0.700000E+01
  10 Alar              0.100000E+06 0.700000E+00 0.400000E+01 0.950000E+00 0.900000E+01 0.800000E+01
  11 Aldrin            0.000000E+00 0.365000E+03 0.200000E+01 0.500000E-01 0.175000E+05 0.490000E+02
  12 Aliette WDG       0.120000E+06 0.100000E+00 0.100000E+00 0.950000E+00 0.166000E+03 0.699000E+01
  13 Ally              0.279000E+04 0.280000E+02 0.250000E+02 0.800000E+00 0.420000E+02 0.558700E+02
  14 AMDRO             0.000000E+00 0.180000E+02 0.990000E+02 0.900000E+00 0.730000E+06 0.270000E+02
  15 AMIBEN 10G        0.700000E+03 0.140000E+02 0.700000E+01 0.950000E+00 0.210000E+02 0.280000E+02
  16 AMID-THIN         0.100000E+03 0.100000E+02 0.500000E+01 0.600000E+00 0.100000E+03 0.343610E+03
  17 AMITROL-T         0.360000E+06 0.100000E+01 0.500000E+01 0.950000E+00 0.930000E+02 0.270000E+02
  18 Ammo              0.000000E+00 0.360000E+02 0.500000E+01 0.400000E+00 0.610000E+05 0.259540E+03
  19 Antor             0.105000E+03 0.900000E+01 0.100000E+02 0.400000E+00 0.100000E+03 0.200000E+02
  20 A-Rest            0.440000E+03 0.150000E+02 0.300000E+02 0.500000E+00 0.830000E+02 0.101000E+04
  21 ARSENAL 2EC       0.500000E+06 0.900000E+02 0.300000E+02 0.800000E+00 0.100000E+03 0.392690E+03
  22 Arsonate          0.140000E+07 0.180000E+03 0.100000E+02 0.100000E+01 0.700000E+04 0.300000E+01
  23 ASANA XL          0.000000E+00 0.108000E+03 0.800000E+01 0.400000E+00 0.527300E+04 0.782400E+02
  24 ASSET 2.5 Gal     0.857000E+03 0.450000E+02 0.180000E+02 0.650000E+00 0.350000E+02 0.500000E+02
  25 ASSET Gal         0.857000E+03 0.450000E+02 0.180000E+02 0.650000E+00 0.350000E+02 0.480000E+02
  26 ASSURE            0.000000E+00 0.600000E+02 0.150000E+02 0.200000E+00 0.540000E+03 0.398530E+03
  27 Asulox            0.550000E+06 0.100000E+02 0.300000E+01 0.950000E+00 0.138000E+03 0.270000E+02
  28 AVENGE            0.817000E+06 0.870000E+02 0.300000E+01 0.950000E+00 0.550000E+05 0.430000E+02
  29 Azodrin           0.100000E+07 0.300000E+02 0.200000E+01 0.950000E+00 0.100000E+01 0.290000E+02
  30 BALAN EC          0.000000E+00 0.510000E+02 0.100000E+02 0.200000E+00 0.824000E+04 0.570000E+02
  31 BANOL             0.100000E+07 0.120000E+02 0.150000E+02 0.950000E+00 0.309000E+03 0.960000E+02
  32 BANVEL            0.360000E+06 0.180000E+02 0.900000E+01 0.650000E+00 0.130000E+02 0.599200E+02
  33 BASAGRAN          0.230000E+07 0.270000E+02 0.200000E+01 0.600000E+00 0.350000E+02 0.528000E+02
  34 Basta             0.137000E+07 0.700000E+01 0.400000E+01 0.950000E+00 0.430000E+03 0.165000E+03
  35 BAYGON EC         0.180000E+04 0.145000E+03 0.990000E+02 0.900000E+00 0.290000E+02 0.106000E+03
```

EPIC multirun file (MLRN1102.DAT)

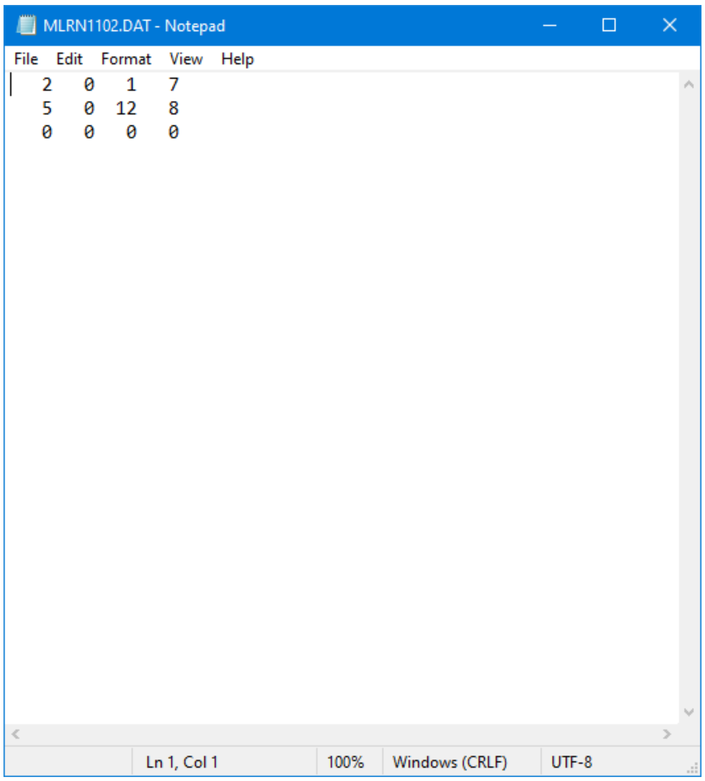
File format: four fields of four characters (integers)4

An EPIC study may involve the analysis of consecutive weather seeds on wind and water erosion without reloading the model. That can be easily done with the multi-run option in EPIC. The simulation continues until a zero NBYR is encountered. Elements included in the EPIC multirun file are listed below.

Field	Variable name	Description
1	`JZ(1)`	Number of years for the second to the last simulation *(cols. 1-4)* This is the number of years simulated with the multirun option. Each additional run is identified by a row in the multirun file. Set it to zero if the multirun option is not used.
2	`JZ(2)`	Soil erosion simulation *(cols. 5-8)* 0 for normal erosion soil profile. 1 for static soil profile erosion control practice factor. Soil profile is reset to the initial condition each year.
3	`JZ(3)`	Input code for weather variables *(cols. 9-12)* 1 Precipitation 2 Maximum and minimum temperatures 3 Solar radiation 4 Average wind speed 5 Average relative humidity If any daily weather variables are input, precipitation must also be input. Thus, it is not necessary to specify ID=1 unless rain is the only input variable For more information see variable NGN in the EPIC control table file (EPICCONT.DAT).
4	`JZ(4)`	Daily weather station *(cols. 13-16)* It is the ID number of the daily weather station to use in the multirun. For more information see variable WITH in the EPIC run file (EPICRUN.DAT).

Figure 22 is an example of the information included in the EPIC multirun file. In the first line, the model will run for 2 years, the normal soil erosion option is used, only precipitation is provided, and the simulation will use the weather data form weather station with ID number 7 in the EPIC daily weather list file (WDLSTCOM.DAT). In the second line. The model will run for five years using the normal soil erosion option. Precipitation and air temperature data are provided using the weather file with ID number eight in the EPIC daily weather list file. The last line stops the multirun because a zero was used for the number of years (JZ(1)).

Figure 23. Example of MLRN1102.DAT file with the list of multiple runs with EPIC1102.




```
  2   0   1   7
  5   0  12   8
  0   0   0   0
```

EPIC parameters file (PARM1102.DAT)

File format: different formats are used to read the EPIC management file.

Line 1-30: fixed format; two fields of 8 characters with 3 decimals (floating).

Line 31-41: fixed format; 10 fields of 8 characters with 2 decimals (floating) on each line.

Line 42: fixed format; 5 fields of 8 characters with 2 decimals (floating).

Line 43: fixed format; 4 fields of 8 characters with 2 decimals (floating).

The EPIC parameters file is a very important part of the EPIC model because many coefficients of the equations included in the model are maintained in this file. The parameters included in this file should be modified with caution during the calibration process.

The file contains two types of parameters, s-curve parameters and general parameters.

S-curve parameters

An S-shaped curve is used to describe the behavior of many processes in EPIC. The y-axis is scaled from 0 to 1 to express the effect of a range in the x-axis variable on the process being simulated. The s-curve may be described adequately by two points contained in this file. It is convenient to represent the x and y coordinates of the two points with two numbers contained in this file. The numbers are split by EPIC (the x-value is left of the decimal and the y-value is right of the decimal). The two points are contained in an array called SCRP.

The procedure can be illustrated using two values as an example: SCRP(1,1) = 90.05 and SCRP(1,2) = 99.95. When split we have x1=90, y1=0.05, x2=99, and y2=0.95. EPIC uses these two points to solve the exponential equation for two parameters that guarantee the curve originates at zero, passes through the two given points, and y approaches 1.0 as x increases beyond the second point. The form of the equation is the following:

$$Y = x/[x + exp(b1 - b2 \times x)]$$

Where b1 and b2 are the EPIC determined parameters.

The S-curve parameters used in EPIC are the following

Line number	Field 1	Field 2	Description
1	`SCRP(1,1)`	`SCRP(1,2)`	Root growth restriction by rock or coarse soil fragments The number to the left of the decimal point is the % coarse fragments, and the number to the right of the decimal point is the fraction of root growth restriction. X = % coarse fragment
2	`SCRP(2,1)`	`SCRP(2,2)`	Soil evaporation – depth Soil evaporation as a function of soil depth. The number to the left of decimal point is depth (mm), and the number to the right is fraction of soil evaporation between soil surface and specified depth. X = soil depth (mm)
3	`SCRP(3,1)`	`SCRP(3,2)`	Potential harvest index The number to the left of decimal point is % of growing season, and the number to the right is fraction of harvest index (drives potential harvest index development as a function of crop maturity). X = % of growing season
4	`SCRP(4,1)`	`SCRP(4,2)`	Runoff curve number This is an exception to normal s-curve procedures. The number to the left of the decimal point is soil water content, and the number to the right is curve number. Soil water fraction taken from SCRP(30,n) to match CN2 and CN3 (average and wet condition runoff curve numbers). THIS IS ALWAYS LEFT AT 0.0, 0.0. SCRP (4) IS CALCULATED BASED ON SCRP(30).
5	`SCRP(5,1)`	`SCRP(5,2)`	Soil Cover Factor Estimates soil cover factor used in simulating soil temperature. The number to the left of the decimal point is the total above ground plant material dead and alive (Mg ha^{-1}) and the number to the right is the soil cover factor (fraction). X = total above ground plant material (dead and live)

Line number	Field 1	Field 2	Description
6	`SCRP(6,1)`	`SCRP(6,2)`	Soil settling rainfall The number to the left of decimal point is rainfall-runoff adjusted for soil texture and depth (mm), and the number to the right of the decimal point is soil settling fraction caused by rainfall. X = rainfall (mm) adjusted for soil texture and depth
7	`SCRP(7,1)`	`SCRP(7,2)`	Aeration stress – root growth The number to the left of decimal point is % of soil water storage volume between critical aeration factor (from CROPCOM.DAT file) and saturation, and the number to the right is % reduction in root growth caused by aeration stress. Determines the root growth aeration stress factor as a function of soil water content and the critical aeration factor for the crop. X = soil water-critical aeration factor
8	`SCRP(8,1)`	`SCRP(8,2)`	N or P deficiency stress – based on plant N or P content The number to the left of decimal point is % of difference between plant N or P content ratios (ratio of actual potential N or P content). The number to the right is the N or P stress factor (=0.0 when N or P ratio = 0.5; = 1.0 when N or P ratio = 1). Determines the plant stress caused by N or P deficiency. X = % of optimal N or P content present in plant
9	`SCRP(9,1)`	`SCRP(9,2)`	Pest damage – temp, water, cover The number to the left of the decimal point is average daily minimum temperature adjusted for soil cover and 30-day antecedent rainfall minus runoff. The number to the right is crop yield reduction by pests expressed as a fraction of the difference between 1.0 and the minimum pest factor (from CROPCOM.DAT). Calculates the pest damage factor as a function of temperature, considering thresholds for 30-day rainfall and above ground plant material. One of several parameters used to regulate pest growth. See also PARM 9 and 10, PSTX in the EPIC control file (EPICCONT.DAT), and PST in the EPIC plant list file (CROPCOM.DAT).

Line number	Field 1	Field 2	Description
9 (cont.)	`SCRP(9,1)` (cont.)	`SCRP(9,2)` (cont.)	X = sum of daily minimum temperature with rainfall adjustment
10	`SCRP(10,1)`	`SCRP(10,2)`	Harvest Index – Plant Water Use The number to the left of the decimal point is the % of actual to potential plant water use during the growing season. The number to the right is the fraction of actual to potential harvest index. Calculates the effect of water stress on harvest index as a function of plant water use. X = plant water use during critical period
11	`SCRP(11,1)`	`SCRP(11,2)`	Plant water stress – plant available water The number to the left of the decimal point is the ratio of root zone soil water content to plant available water storage volume, and the number to the right of the decimal point is the fraction of plant stress due to water stress. Estimates plant water stress as a function of plant available water stored. If Parm 35 = 1 then plant water stress is strictly a function of ET. X = ratio of root zone soil water content to plant available water storage volume
12	`SCRP(12,1)`	`SCRP(12,2)`	N volatilization, as a function of NH_3 depth in soil The number to the left of the decimal point is the depth at the center of soil layer (mm) and the number to the right is the nitrogen volatilization in (kg ha^{-1}). Governs nitrogen volatilization as a function of soil depth. X = depth at the center of a soil layer (mm)
13	`SCRP(13,1)`	`SCRP(13,2)`	Wind erosion - vegetative cover factor Calculates wind erosion vegetative cover factor as a function of above ground plant material. The number to the left of decimal point is vegetative equivalent in (Mg ha^{-1}) and the number to the right is wind erosion cover factor (fraction). X = vegetative equivalent (C1*BIOM+C2*STD+C3*RSD). Where C1, C2, and C3 are coefficients, BIOM is above

Line number	Field 1	Field 2	Description
13 (cont.)	`SCRP(13,1)` (cont.)	`SCRP(13,2)` (cont.)	ground biomass, STD is standing dead plant residue, and RSD is flat residue.
14	`SCRP(14,1)`	`SCRP(14,2)`	Soil temperature – microbial processes Calculates soil temperature factor used in regulating microbial processes. The number to the left of the decimal point is soil temperature and the number to the right is factor (fraction). X = soil temperature (°C)
15	`SCRP(15,1)`	`SCRP(15,2)`	Plant population in water erosion C-factor The number to the left of decimal point is plant population in plants per m^2 or plants per ha for trees, and the number to the right is the water erosion cover factor (fraction) or the fraction of erosion control. Estimates plant population effect on USLE C-factor. X = plant population (plants m^{-2} or plants (trees) ha^{-1})
16	`SCRP(16,1)`	`SCRP(16,2)`	Snowmelt function Increases snow melt as a function of time since the last snowfall. The number to the left of the decimal point is the time (days) since the last snowfall, and the number to the right of the decimal is the rate of melt as a function of time. X = time since the last snowfall (days).
17	`SCRP(17,1)`	`SCRP(17,2)`	Soil snow cover Estimates the snow cover factor as a function of snow present. The number to the left of the decimal point is the amount of snow present (mm of water) and the number on the right is the fraction of soil covered. X = snow present (mm water)
18	`SCRP(18,1)`	`SCRP(18,2)`	Soil temperature – soil erosion Expresses soil temperature effect on erosion of frozen soils. X = temperature of second soil layer (°C)

Line number	Field 1	Field 2	Description
19	SCRP(19,1)	SCRP(19,2)	Water table – ground water storage Drives water table between maximum and minimum limits as a function of ground water storage. X = % of maximum ground water storage
20	SCRP(20,1)	SCRP(20,2)	Soil oxygen – soil depth Simulates oxygen content of soil as a function of depth. Used in microbial processes of residue decay. The number to the left of the decimal point is the depth to center of each soil layer (m) and the number to the right of the decimal point is the adjustment to the oxygen content. This parameter works in conjunction with Parm 53. (1 – Parm 53) x SCRP20 X = depth to center of each soil layer (m)
21	SCRP(21,1)	SCRP(21,2)	Plant water stress – soil water tension Governs plant water stress as a function of soil water tension. X = gravimetric + osmotic tension
22	SCRP(22,1)	SCRP(22,2)	Not used
23	SCRP(23,1)	SCRP(23,2)	Ground cover – leaf area index Estimates plant ground cover as a function of leaf area. The number to the left of the decimal point is the leaf area, and the number to the right of the decimal point is the fraction of ground cover. X = total LAI of all growing plants
24	SCRP(24,1)	SCRP(24,2)	Soil oxygen – soil carbon clay content Simulates oxygen content of the soil as a function of carbon and clay content. This S-curve number is used in microbial processes of residue decay. X = F(Carbon/Clay)
25	SCRP(25,1)	SCRP(25,2)	Not Used

Line number	Field 1	Field 2	Description
26	SCRP(26,1)	SCRP(26,2)	Ground cover – standing live biomass Estimates plant ground cover as a function of standing live biomass. The number to the left of the decimal point is the standing live biomass (Mg ha^{-1}), and the number to the right of the decimal point is the fraction of ground cover. X = standing live biomass (Mg ha^{-1})
27	SCRP(27,1)	SCRP(27,2)	Biological mixing – residue Increases biological mixing in soil layer 1 as residue increases. X = soil layer 1 residue in Mg ha^{-1}
28	SCRP(28,1)	SCRP(28,2)	Soil surface temperature Adjusts the soil surface temperature during the cold season considering the solar radiation. Suggested values: • SCRP(28,1) = 10.01 • SCRP(28,2) = 20.90
29	SCRP(29,1)	SCRP(29,2)	Leaf fall function Time drive function to simulate leaf fall for trees. Suggested values: • SCRP(29,1) = 75.01 • SCRP(29,2) = 95.99
30	SCRP(30,1)	SCRP(30,2)	Soil water content – curve number Exception to normal s-curve procedure; sets soil water contents coinciding with CN2 and CN3. X1 = soil water content as % of field capacity – wilting point X2 = soil water content as % of saturation – field capacity This parameter does not follow the same X, qY format as the other parameters. In this case Y is always 0. EXAMPLE: X1 = 45.00; this indicates that CN2 is 45% of the volume between field capacity and wilting point:

Line number	Field 1	Field 2	Description
30	`SCRP(30,1)`	`SCRP(30,2)`	(0.45*(FC-WP) + WP).
(cont.)	`(cont.)`	`(cont.)`	X2 = 10.00; this indicates that CN3 is 10% of the volume between saturation and field capacity: (0.10*(SAT-FC) + FC).

General parameters

The general parameters contained in this file are used in several equations that replicate physical, chemical, and biological processes. The general parameters used in the EPIC model are listed below.

Line - Field	PARM name and number	Description
L31 – F1	`PRMT(1)`	Crop canopy-PET *(cols. 1-8)* Factor used to adjust crop canopy resistance in the Penman-Monteith PET equation. Default setting: 1.5 *(Range: 1.0 to 2.0)*
L31 – F2	`PRMT(2)`	Root growth-soil strength *(cols. 9-16)* Used to estimate root growth stress created by soil strength. PARM(2) is usually set between 1.15 and 1.2. High values minimize soil strength constraint on root growth. Setting PARM(2) = 2 eliminates all root growth stress. Default setting: 2.0 *(Range: 1.0 to 2.0)*
L31 – F3	`PRMT(3)`	Water stress-harvest index *(cols. 17-24)* Sets fraction of growing season when water stress starts reducing harvest index. Default setting: 0.75 *(Range: 0.0 to 1.0)*
L31-F4	`PRMT(4)`	Not used *(cols. 25-32)*

Line - Field	PARM name and number	Description
L31-F5	`PRMT(5)`	Soil water lower limit *(cols. 33-40)* Lower limit of water content in the top 0.5 m soil depth expressed as a fraction of the wilting point water content. Default setting: 0.5 *(Range: 0.0 to 1.0)*
L31-F6	`PRMT(6)`	Winter dormancy (h) *(cols. 41-48)* Causes dormancy in winter grown crops. Growth does not occur when day length is less than annual minimum day length + PARM(6). It is used to simulate dormancy. Default setting: 0.1 *(Range: 0.0 to 1.0)*
L31-F7	`PRMT(7)`	N fixation *(cols. 49-56)* Drives the process to estimate nitrogen fixation for legumes. At 1, fixation is limited by soil water or nitrate content or by crop growth stage. At 0 fixation meets crop nitrogen uptake demand. A combination of the two previously described scenarios is obtained by setting 0 < PARM(7) < 1. Default setting: 0.99 *(Range: 0.0 to 1.0)*
L31-F8	`PRMT(8)`	Soluble phosphorus runoff coefficient (0.1 m^3 Mg^{-1}) *(cols. 57-64)* P concentration in sediment divided by that of the water. Default setting: 15.0 *(Range: 10 to 20)*
L31-F9	`PRMT(9)`	Pest damage moisture threshold (mm) *(cols. 65-72)* It is used to regulate pest growth. The moisture considered is the previous 30-day rainfall minus runoff. See also PARM(10), PSTX in the

Line - Field	PARM name and number	Description
L31-P9 (cont.)	`PRMT(9)` `(cont.)`	EPICCONT.DAT file, PST in the CROPCOM.DAT file, and SCRP(9) above in this section. Default setting: 25.0 Large value (e.g., >500) turns off the simulation of pest damage. *(Range: 25 to 250)*
L31-F10	`PRMT(10)`	Pest damage cover threshold (Mg ha^{-1}) *(cols. 73-80)* It is one of several parameters used to regulate pest growth. It considers crop residue + above ground biomass. This is the amount of residues required for pests to begin to grow. Setting PARM(10) at a large number (e.g., >50) will result in little or no pest growth because it will be impossible to reach such high levels of residue. See also PARM(10), PSTX in the EPICCONT.DAT file, PST in the CROPCOM.DAT file, and SCRP(9) above in this section. Default setting: 1.0 *(Range: 0 to 50)*
L32-F1	`PRMT(11)`	Moisture required for seed germination (fraction) *(cols. 1-8)* Sets the minimum amount of moisture in the plow depth layer (set with PARM(16)) required to allow seed germination. PARM(11) refers to the fraction of available water in the plow depth that is required for germination. If PDSW/PDAW>PARM(11), germination will occur. PDSW is the soil water content present in the plow depth layer. PDAW is the plant available water (soil water at field capacity less the soil water at wilting point) in the plow depth layer. Typical values range from 0.3 to 0.9 for this parm. Setting the parm value <=0 essentially turns this parm off and germination will occur regardless of moisture content in the soil. Default setting: -100 (turned off) *(Range: 0.0 to 1.0)*
L32-F2	`PRMT(12)`	Soil evaporation coefficient *(cols. 9-16)* Governs rate of soil evaporation from top 0.2 m of soil. Small values increase soil evaporation. Default setting: 2.5 *(Range: 1.5 to 2.5)*

Line - Field	PARM name and number	Description
L32-F3	`PRMT(13)`	Hargreaves PET equation exponent *(Cols. 17-24)* The original value of 0.5 was modified to 0.6 to increase evapotranspiration. If set to zero, the EPIC model will estimate the value of PARM(13) based on average climate condition of the study site. Default setting: 0.5 *(Range: 0.5 to 0.6)*
L32-F4	`PRMT(14)`	Nitrate leaching ratio *(cols. 25-32)* Ratio of nitrate concentration in surface runoff to nitrate concentration in percolate. A small value reduces nitrate concentration in runoff. Default setting: 1.0 *(Range: 0.1 to 1.0)*
L32-F5	`PRMT(15)`	Not used *(cols. 33-40)*
L32-F6	`PRMT(16)`	Plow layer depth (m) *(cols. 41-48)* Used to track soluble phosphorus concentration or weight, organic carbon, and soil water content. Default setting: 0.15 *(Range: 0.05 to 0.2)*
L32-F7	`PRMT(17)`	Crack flow coefficient *(cols. 49-56)* Fraction of inflow to a soil layer allowed to flow in cracks. Default setting: 0.0 *(Range: 0.0 to 1.0)*
L32-F8	`PRMT(18)`	Pesticide leaching ratio *(cols. 57-64)* Pesticide concentration in surface runoff to pesticide concentration in percolate. Default setting: 0.1 *(Range: 0.1 to 1.0)*

Line - Field	PARM name and number	Description
L32-F9	`PRMT(19)`	Fraction of maturity at spring growth initiation *(cols. 65-72)* Allows fall growing crops to reset heat unit index to a value greater than 0 when passing through the minimum temperature month. Default setting: 0.5 *(Range: 0.0 to 1.0)*
L32-F10	`PRMT(20)`	Microbial decay rate coefficient (cols. 73-80) Adjusts soil water-temperature-oxygen equation. Default setting: 1.0 *(Range: 0.5 to 1.5)*
L33-F1	`PRMT(21)`	KOC for carbon loss in water and sediment *(cols. 1-8)* KD = KOC × C. Default setting: 1000 *(Range: 500 to 1500)*
L33-F2	`PRMT(22)`	Potassium pool flow coefficient (cols. 9-16) Regulates flow between exchangeable and fixed potassium pools. Default setting: 0.00025 (Range: 0.00001 to 0.0005)
L33-F3	`PRMT(23)`	Exponential coefficient in RUSLE C factor equation *(cols. 17-24)* Used in estimating the residue effect. Default setting: 0.75 *(Range: 0.5 to 1.5)*
L33-F4	`PRMT(24)`	Maximum depth for biological mixing (m) *(cols: 25-32)* Default setting: 0.3 *(Range: 0.1 to 0.3)*

Line - Field	PARM name and number	Description
L33-F5	`PRMT(25)`	Biological mixing efficiency *(cols. 33-40)* Simulates mixing in topsoil by earth worms etc. Default setting: 0.03 *(Range: 0.01 to 0.05)*
L33-F6	`PRMT(26)`	Exponential coefficient in RUSLE C factor equation *(cols. 41-48)* Used in estimating the effect of growing plants. Reduce to reduce C and erosion. Default setting: 0.1 *(Range: 0.05 to 0.2)*
L33-F7	`PRMT(27)`	Lower limit nitrate concentration (g N/Mg soil) *(cols: 49-56)* Maintains soil nitrate concentration at or above PARM(27). Default setting: 0.01 *(Range: 0.01 to 10.0)*
L33-F8	`PRMT(28)`	Acceptable plant N stress level *(cols. 57-64)* Used to estimate annual nitrogen application rate as part of the automatic fertilizer scheme. Default setting: 1.0 *(Range: 0.1 to 1.0)*
L33-F9	`PRMT(29)`	Potassium pool flow coefficient *(cols. 65-72)* Regulates flow between soluble and exchangeable potassium pools. Default setting: 0.01 *(Range: 0.001 to 0.02)*
L33-F10	`PRMT(30)`	Oxygen-depth function method *(cols. 73-80)* Sets the amount of oxygen present in the soil based on depth or clay content. At 0.0 the calculation of the oxygen-depth function is based on the original EPIC approach, which is based on depth in the soil profile (see SCRP(20)). At 1.0 the calculation of the oxygen-depth function is based on the Kemanian approach, which is based on the clay content in the soil profile (see SCRP(24)). A combination of the two methods is obtained by setting 0.0 < PARM(30) < 1.0.

Line - Field	PARM name and number	Description
L33-F10 (cont.)	`PRMT(30)` (cont.)	Usage in the code is: [PARM(30) × K + (1- PARM(30)) × E] where K = Kemanian method and E = EPIC method. Default setting: 0.5 *(Range: 0.0 to 1.0)*
L34-F1	`PRMT(31)`	Furrow irrigation sediment routing exponent *(cols. 1-8)* Exponent of water velocity function for estimating potential sediment concentration. Default setting: 1.0 *(Range: 1.0 to 1.5)*
L34-F2	`PRMT(32)`	Minimum C factor value *(cols. 9-16)* It is the minimum C factor value in EPIC soil erosion equation. Default setting: 0.01 *(Range: 0.0001 to 0.8)*
L34-F3	`PRMT(33)`	Puddling saturated conductivity (mm h^{-1}) *(cols. 17-24)* Used to simulate puddling in rice paddies by setting second soil layer saturated conductivity to the value set with PARM(33). Default setting: 0.001 *(Range: 0.00001 to 0.1)*
L34-F4	`PRMT(34)`	Soluble P runoff exponent *(cols. 25-32)* Used in the modified GLEAMS method makes soluble phosphorus runoff concentration a nonlinear function of organic phosphorus concentration in soil layer 1. Default setting: 1.0 *(Range: 1.0 to 1.5)*

Line - Field	PARM name and number	Description
L34-F5	`PRMT(35)`	Water stress weighting coefficient *(cols. 33-40)* Defines how the water stress is estimated during the simulation. At 0 plant water stress is strictly a function of soil water content; at 1 plant water stress is strictly a function actual ET divided by potential ET. 0 < PARM(35) < 1 considers both approaches. Default setting: 0.5 *(Range: 0.0 to 1.0)*
L34-F6	`PRMT(36)`	Furrow irrigation base sediment concentration (Mg m^{-3}) *(cols. 41-48)* Potential sediment concentration when flow velocity = 1 (m sec^{-1}). Default setting: 0.1 *(Range: 0.01 to 0.2)*
L34-F7	`PRMT(37)`	Pest kill scaling factor *(cols. 49-56)* Scales pesticide kill effectiveness to magnitude of pest growth index. Default setting: 100 *(Range: 100 to 10000)*
L34-F8	`PRMT(38)`	Hargreaves PET equation coefficient *(cols. 57-64)* Original value = 0.0023. modified to 0.0032 to increase PET. Default setting: 0.0032 *(Range: 0.0023 to 0.0032)*
L34-F9	`PRMT(39)`	Auto N fertilizer scaling factor *(cols. 65-72)* Sets initial annual crop N use considering WA and BN3 from the CROPCOM.DAT file. Default setting: 300 *(Range: 50 to 500)*
L34-F10	`PRMT(40)`	Not used *(cols. 73-80)*

Line - Field	PARM name and number	Description
L35-F1	`PRMT(41)`	Soil evaporation-cover coefficient *(cols. 1-8)* Regulates soil water evaporation as a function of soil covered by flat and standing residue, and growing biomass. Default setting: 0.1 *(Range: 0.01 to 0.2)*
L35-F2	`PRMT(42)`	SCS curve number index coefficient *(cols. 9-16)* Regulates the effect of PET in driving the SCS curve number retention parameter. This parameter works only when NVCN in control table file (EPICCONT.DAT) is equal to 4. Default setting: 1.0 *(Range: 0.3 to 2.5)*
L35-F3	`PRMT(43)`	Upward movement of soluble P *(cols. 17-24)* Regulates the upward movement of soluble phosphorus by evaporation. Default setting: 1.0 *(Range: 1.0 to 20.0)*
L35-F4	`PRMT(44)`	Soluble C in runoff to percolate ratio *(cols. 25-32)* Ratio of soluble C concentration in runoff to percolate. Default setting: 0.5 (Range: 0.1 to 1.0)
L35-F5	`PRMT(45)`	CENTURY eq. coefficient *(cols. 33-40)* Coefficient in century equation allocating slow to passive humus Default setting: 0.003. *(Range: 0.001 to 0.05)*
L35-F6	`PRMT(46)`	Auto fertilizer weighting factor *(cols. 41-48)* Adjusts the approach used to set automatic nitrogen fertilization. At 0.0 nitrogen application equals average annual nitrogen in crop yield. At 1.0 the nitrogen stress function is used to set nitrogen application. The two methods are weighted with PARM(46) for values between 0.0 and 1.0.

Line - Field	PARM name and number	Description
L35-F6 (cont.)	`PRMT(46)` (cont.)	Default setting: 1.0 *(Range: 0.0 to 1.0)*
L35-F7	`PRMT(47)`	CENTURY eq. slow humus transformation *(cols. 49-56)* Century slow humus transformation rate. Default setting: 0.000548 *(Range: 0.00041 to 0.00068)*
L35-F8	`PRMT(48)`	CENTURY eq. passive humus transformation *(cols. 57-64)* Century passive humus transformation rate Default setting: 0.000012 *(Range: 0.0000082 to 0.000015)*
L35-F9	`PRMT(49)`	Fraction of above ground plant material burned *(cols. 65-72)* Burning operation destroys specified fraction of above ground biomass and standing and flat residue. Default setting: 0.9 *(Range: 0.5 to 1.0)*
L35-F10	`PRMT(50)`	Technology annual rate coefficient *(cols. 73-80)* Linear adjustment to harvest index – base year = 2000. Set to zero for level technology. Increase to increase technology effect on crop yield. With constant PARM(50) > 0.0, the effect of technology increases year after year. Default setting: 0.0 *(Range: 0.0 to 0.01)*
L36-F1	`PRMT(51)`	Microbial activity adjustment *(cols. 1-8)* Adjusts the microbial activity function in topsoil layer. Default setting: 0.5 *(Range: 0.1 to 1.0)*

Line - Field	PARM name and number	Description
L36-F2	`PRMT(52)`	Tillage – residue decay rate *(cols. 9-16)* Exponential coefficient in equation expressing tillage effect on residue decay rate. Default setting: 10.0 *(Range: 5.0 to 15.0)*
L36-F3	`PRMT(53)`	Oxygen effect – microbial activity *(cols. 17-24)* Coefficient in oxygen equation used in modifying microbial activity with soil depth. It works along with SCRP(20). Default setting: 0.9 *(Range: 0.8 to 0.95)*
L36-F4	`PRMT(54)`	Water use – root growth *(cols. 25-32)* Exponential coefficient in potential water use root growth distribution equation. Default setting: 5.0 *(Range: 2.5 to 7.5)*
L36-F5	`PRMT(55)`	Weight for root growth approach *(cols. 33-40)* Coefficient used in allocating root growth between two functions. At 0 root growth is simulated as exponential distribution of depth; at 1 root growth is simulated as a function of water use. Values between 0 and 1 weight the two functions. Default setting: 0.0 *(Range: 0.0 to 1.0)*
L36-F6	`PRMT(56)`	Root growth distribution – depth *(cols. 41-48)* Exponential coefficient in root growth distribution by depth function. Default setting: 5.0 *(Range: 5.0 to 10.0)*

Line - Field	PARM name and number	Description
L36-F7	`PRMT(57)`	Volatilization/nitrification partitioning coefficient *(cols. 49-56)* Fraction of process allocated to volatilization. Default setting: 0.1 *(Range: 0.05 to 0.5)*
L36-F8	`PRMT(58)`	Runoff amount to delay pest application (mm) *(cols. 57-64)* Pesticide is not applied on days with runoff greater than PARM(58). Default setting: 500.0 (no delay) *(Range: 0.0 to 25.0)*
L36-F9	`PRMT(59)`	Soil water value to delay tillage *(cols. 65-72)* Tillage is delayed when PDSW/FCSW>PARM(59). PDSW = Plow depth soil water content FCSW = Field capacity soil water content Setting PARM(59) to a value greater than 1.0 will turn off this option giving no delay in tillage operations. Default setting: 10.0 (no delay) *(Range: 0.0 to 1.0)*
L36-F10	`PRMT(60)`	Estimation of USLE C factor *(cols. 73-80)* Relates USLE C factor to soil covered by flat and standing residue and growing biomass. Default setting: 1.0 *(Range: 0.5 to 2.0)*
L37-F1	`PRMT(61)`	Weighting factor for estimating soil evaporation *(cols. 1-8)* This parameter allows to weigh the approach used in estimating the soil evaporation. At 0 total compensation of water deficit is allowed between soil layers. At 1 no compensation is allowed. 0.0 < PARM(61) < 1.0 gives partial compensation. Default setting: 0.0 *(Range: 0.0 to 1.0)*

Line - Field	PARM name and number	Description
L37-F2	`PRMT(62)`	Upward nitrogen movement *(cols. 9-16)* Exponential coefficient regulates upward N movement by evaporation increasing PARM(62) increases upward N movement. Default setting: 1.0 *(Range: 0.2 to 2.0)*
L37-F3	`PRMT(63)`	Nitrogen concentration in leaching (ppm) *(cols. 17-24)* Upper limit of N concentration in percolating water. Default setting: 1000 *(Range: 100 to 10000)*
L37-F4	`PRMT(64)`	Nitrification – volatilization *(cols. 25-32)* Upper limit of nitrification-volatilization as a fraction of NH_3 present. Default setting: 0.5 *(Range: 0.0 to 1.0)*
L37-F5	`PRMT(65)`	Curve number – frozen soil *(cols. 33-40)* Reduces NRCS runoff curve number retention for frozen soil. Fraction of S (retention Parameter) when soil is frozen. Reduced to increase runoff from frozen soils. Default setting: 0.05 *(Range: 0.05 to 0.5)*
L37-F6	`PRMT(66)`	Standing dead fall rate *(cols. 41-48)* Governs rate of standing dead conversion to flat residue. Default setting: 0.01 *(Range: 0.0001 to 0.1)*

Line - Field	PARM name and number	Description
L37-F7	`PRMT(67)`	Wind erosion – wind speed (m sec^{-1}) *(cols. 49-56)* Sets wind speed threshold to simulate wind driven soil erosion. Wind driven soil erosion is not simulated if wind speed is less than the threshold set with PARM(67). Default setting: 6.0 *(Range: 4.0 to 10.0)*
L37-F8	`PRMT(68)`	Nitrogen fixation upper limit (kg ha^{-1} d^{-1}) *(cols. 57-64)* Sets the daily nitrogen fixation upper limit. Default setting: 2.0 *(Range: 1.0 to 30.0)*
L37-F9	`PRMT(69)`	Heat unit adjustment at harvest *(cols. 65-72)* If PARM(69) > 0.0, sets back the heat units to a fraction controlled by PARM(69) and by harvest index. Default setting: 0.0 *(Range: 0.0 to 1.0)*
L37-F10	`PRMT(70)`	Day length – LAI development *(cols. 73-80)* Power of change in day length component of LAI growth equation. Causes faster growth in spring and slower growth in fall. Default setting: 3.0 *(Range: 1.0 to 10.0)*
L38-F1	`PRMT(71)`	RUSLE 2 transport capacity parameter *(cols. 1-8)* Regulates deposition as a function of particle size and flow rate. Default setting: 0.001 *(Range: 0.001 to 0.1)*
L38-F2	`PRMT(72)`	RUSLE 2 Threshold transport capacity coefficient *(cols. 9-16)* Adjusts threshold (flow rate × slope steepness). Default setting: 3.0 (Range: 1.0 to 10.0)

Line - Field	PARM name and number	Description
L38-F3	`PRMT(73)`	Curve number retention parameter *(cols. 17-24)* Sets the upper limit of curve number retention parameter S. SUL = PARM(73)×S1 allows CN to go below CN1. Default setting: 1.2 *(Range: 1.0 to 2.0)*
L38- F4	`PRMT(74)`	Penman-Monteith adjustment factor *(cols. 25-32)* Adjusts PM PET estimates. PARM(74)=1.0 results in no adjustment of the PM PET estimates. Default setting: 1.0 *(Range: 0.5 to 1.5)*
L38-F5	`PRMT(75)`	Runoff CN residue adjustment parameter *(cols. 33-40)* Increases runoff for RSD<1.0 Mg ha^{-1}. Decreases for RSD>1.0. Default setting: 0.0 *(Range: 0.0 to 0.3)*
L38-F6	`PRMT(76)`	Harvest index adjustment for fruit and nut trees *(cols. 41-48)* Reduces yield when crop available soil water is less than PARM(76) Default setting: 1000 *(Range: 100 to 1500)*
L38-F7	`PRMT(77)`	Phosphorus flux labile and active pool *(cols. 49-56)* Coefficient regulating P flux between labile and active pool. RMN = PARM(77) × WPML – WPMA × RTO RMN: mineralization rate WPML: content of labile P in layer WPMA: weight of active mineral P pool RTO: ratio PSP/1-PSP PSP: Phosphorus sorption ratio

Line - Field	PARM name and number	Description
L38-F7 (cont.)	`PRMT(77)` (cont.)	Default setting: 0.0001 *(Range: 0.0001 to 0.001)*
L38-F8	`PRMT(78)`	Phosphorus flux active and stable pool *(cols. 57-64)* Coefficient regulating P flux between active and stable pool. ROC = PARM(78) × BK × 4.0 × WPMA – WPMS ROC: rate of stable P mineralization pool BK: rate constant that governs flow between active and mineral WPMS: weight of stable P pool Default setting: 0.0001 *(Range: 0.0001 to 0.001)*
L38-F9	`PRMT(79)`	Factor for locating appropriate weather stations *(cols. 65-72)* If IWTH in the EPIC run file (EPICRUN.DAT) is set to zero not providing a weather station, the EPIC model will identify a weather station to use for the simulation. With PARM(79) at 0.0 the weather station is identified giving priority to elevation. With PARM(79) at 1.0 the weather station is located giving priority to distance. 0.0 < PARM(79) < 1.0 considers both approaches. Default setting: 0.9 *(Range: 0.0 to 1.0)*
L38-F10	`PRMT(80)`	Partitions of N_2 and N_2O from denitrification *(cols. 73-80)* N_2 fraction of denitrification in original EPIC denitrification function. Default setting: 0.2 *(Range: 0.1 to 0.9)*
L39-F1	`PRMT(81)`	Runoff curve number adjustment *(cols. 1-8)* Used to adjust runoff volume. This parameter works only when NVCN in control table file (EPICCONT.DAT) is equal to 0. Default setting: 1.0 *(Range: 0.1 to 2.0)*

Line - Field	PARM name and number	Description
L39-F2	`PRMT(82)`	Biomass pool transformation approach *(cols. 9-16)* Microbial N:C ratio at which N immobilization is maximum. PARM(82) = CRLNC in model source code. Default setting: 0.0667 *(Range: 0.025 to 0.075)*
L39-F3	`PRMT(83)`	Biomass pool transformation approach *(cols. 17-24)* Microbial N:C ratio at which N immobilization ceases. PARM(83) = CRUNC in model source code. Default setting: 0.2 *(Range: 0.04 to 0.2)*
L39-F4	`PRMT(84)`	Specific base rate for ammonification (1/day) *(cols. 25-32)* PARM(84) = WKA in model source code. Used in Phoenix C N dynamic approach (see ICP in EPICCONT.DAT). Default setting: 0.3 *(Range: 0.2 to 0.4)*
L39-F5	`PRMT(85)`	Microbial N:C ratio at which ammonification is maximum *(cols. 33-40)* PRMT(85) = WNCMIN in model source code. Used in Phoenix C N dynamic approach (see ICP in EPICCONT.DAT). Default setting: 0.0667 *(Range: 0.025 to 0.075)*
L39-F6	`PRMT(86)`	Microbial N:C ratio at which ammonification ceases *(cols. 41-48)* PARM(86) = WNCMAX in model source code. Used in Phoenix C N dynamic approach (see ICP in EPICCONT.DAT). Default setting: 0.2 *(Range: 0.04 to 0.2)*

Line - Field	PARM name and number	Description
L39-F7	`PRMT(87)`	Maximum rate of uptake of nitrogen during immobilization (gN gC^{-1} day^{-1}) *(cols. 49-56)* PARM(87) = VMU in model source code. Used in Phoenix C N dynamic approach (see ICP in EPICCONT.DAT). Default setting: 0.0075 *(Range: 0.00675 to 0.00825)*
L39-F8	`PRMT(88)`	Half Saturation constant for ammonia immobilization (mg N L^{-1}) *(cols. 57-64)* PARM(88) = WKMNH3 in model source code. Used in Phoenix C N dynamic approach (see ICP in EPICCONT.DAT). Default setting: 2.0 *(Range: 1.8 to 2.2)*
L39-F9	`PRMT(89)`	Half Saturation constant for nitrite immobilization (mg N L^{-1}) *(cols. 65-72)* PARM(89) = WKMNO2 in model source code. Used in Phoenix C N dynamic approach (see ICP in EPICCONT.DAT). Default setting: 1.0 *(Range: 0.9 to 1.1)*
L39-F10	`PRMT(90)`	Half Saturation constant for nitrate immobilization (mg N L^{-1}) *(cols. 73-80)* PARM(90) = WKMNO3 in model source code Used in Phoenix C N dynamic approach (see ICP in EPICCONT.DAT). Default setting: 1.0 *(Range: 0.9 to 1.1)*

Line - Field	PARM name and number	Description
L40-F1	`PRMT(91)`	Nitrogen plant uptake *(cols. 1-8)* Sets the fraction of plant nitrogen uptake in NO_3 form, the reminder of nitrogen uptake is in NH_3 form. Default setting: 0.9 *(Range: 0.1 to 0.95)*
L40-F2	`PRMT(92)`	Root decay lag factor *(cols. 9-16)* Prevents abrupt changes in root mass when standing live changes dramatically. Lag is directly related to factor and small values allow quicker change in root mass when standing live biomass changes. Default setting: 0.9 *(Range: 0.0 to 1.0)*
L40-F3	`PRMT(93)`	Vertical Percolation Exponent *(cols. 17-24)* Exponent for calculating vertical percolation in /.soil layers as a function of actual hydraulic conductivity using the VSHC method (see IPRK in EPICCONT.DAT file) Default setting: 3.0 *(Range: 1.0 to 6.0)*
L40-F4	`PRMT(94)`	Radiation soil temperature factor *(cols. 25-32)* XZ=0.5×(TMX-TMN)×ST0/PARM(94) TMX = max air temperature TMN = min air temperature ST0 = solar radiation Default setting: 15.0 *(Range: 10.0 to 20.0)*

Line - Field	PARM name and number	Description
L40-F5	`PRMT(95)`	Damping depth for soil temperature factor *(cols. 33-40)* X7=PARM(95)×Z/DD Z = depth to the bottom of the soil layer DD = damping depth Default setting: 1.0 *(Range: 0.5 to 1.5)*
L40-F6	`PRMT(96)`	NH_3: NO_3 mineralization ratio *(cols. 41-48)* Adjusts the NH_3:NO_3 mineralization ratio. At 1.0 all the mineralized nitrogen goes to NH_3. At 0.0 all the mineralized nitrogen goes to NO_3. Default setting: 0.5 *(Range: 0.0 to 1.0)*
L40-F7	`PRMT(97)`	Vegetative cover factor upper limit *(cols. 49-56)* Sets the upper limits of the vegetative cover factor used in the simulation of soil temperature. Default setting: 0.7 *(Range: 0.1 to 0.9)*
L40-F8	`PRMT(98)`	Snow cover factor upper limit *(cols. 57-64)* Sets the upper limits of the snow cover factor used in the simulation of the soil temperature. Default setting: 0.95 *(Range: 0.75 to 0.99)*
L40-F9	`PRMT(99)`	Daily weather – soil surface temperature *(cols. 65-72)* Used in the enhanced cosine function approach (see ISLT in EPICCONT.DAT file), it regulates the effect of actual daily weather on the soil surface temperature. It adjusts the difference between the soil surface temperature estimated with the cosine function and the soil surface temperature estimated considering solar radiation, air temperature, and soil cover factor. Default setting: 0.6 *(Range: 0.5 to 0.95)*

Line - Field	PARM name and number	Description
L40-F10	`PRMT(100)`	Soil layer depth – layer temperature *(cols. 73-80)* Used in the enhanced cosine approach (see ISLT in EPICCONT.DAT file), it regulates the effect of soil layer depth and damping depth on the estimated soil layer temperature. Default setting: 2.0 *(Range: 0.7 to 2.0)*
L41-F1	`PRMT(101)`	Soil surface temperature transfer adjustment *(cols. 1-8)* Used in temperature transfer approach (see ISLT in EPICCONT.DAT file), it adjusts the temperature transfer coefficient. When set at 1.0, it gives full effect of daily weather and soil cover causing large variation in soil temperature estimation from day to day. When PARM(101) approaches 0.0, estimated soil temperature becomes a smooth cosine curve repeating itself every year. Default setting: 0.6 *(Range: 0.0 to 1.0)*
L41-F2	`PRMT(102)`	Soil temperature transfer adjustment *(cols. 9-16)* Used in the temperature transfer approach (see ISLT in EPICCONT.DAT file), it adjusts the temperature transfer between soil layers. Default setting: 0.9 *(Range: 0.0 to 1.0)*
L41-F3	`PRMT(103)`	Bottom soil layer temperature estimation *(cols. 17-24)* Used in the temperature transfer approach (see ISLT in EPICCONT.DAT file), it regulates the soil temperature in the bottom soil layer as a function of soil depth and damping depth. Default setting: 1.5 *(Range: 1.0 to 3.0)*
L41-F4	`PRMT(104)`	Not used *(cols. 25-32)*
L41-F5	`PRMT(105)`	Not used *(cols. 33-40)*

Line - Field	PARM name and number	Description
L42-F1	`COIR`	Cost of irrigation water (\$ mm^{-1}) *(cols. 1-8)* Used for economic analysis, it is the cost per millimeter of water used for irrigation.
L42-F2	`COL`	Cost of lime (\$ Mg^{-1}) *(cols. 9-16)* Used for economic analysis, it is the cost per metric ton (1 megagrams) of lime applied to the soil.
L42-F3	`FULP`	Cost of fuel (\$ L^{-1}) *(cols. 17-24)* Used for economic analysis, it is the cost per liter of fuel used to power machines in various management operations.
L42-F4	`WAGE`	Cost of labor (\$ h^{-1}) *(cols. 25-32)* Used for economic analysis, it is the cost for one hour of labor.
L42-F5	`CSTZ(1)`	Miscellaneous cost 1 (\$ ha^{-1}) *(cols. 33-40)*
L42-F6	`CSTZ(2)`	Miscellaneous cost 2 (\$ ha^{-1}) *(cols. 41-48)*
L43-F1	`XKN50`	Michaelis-Menten NO_3^- reduction constant (g m^{-3}) *(cols. 1-8)* Used in the Izaurralde denitrification approach (see IDN in EPICCONT.DAT file). Default setting: 250 *(Range: 100 to 500)*
L43-F2	`XKN30`	Michaelis-Menten NO_2^- reduction constant (g m^{-3}) *(cols. 9-16)* Used in the Izaurralde denitrification approach (see IDN in EPICCONT.DAT file). Default setting: 25 *(Range: 15 to 40)*
L43-F3	`XKN10`	Michaelis-Menten N2O reduction constant (g m^{-3}) *(cols. 17-24)* Used in the Izaurralde denitrification approach (see IDN in EPICCONT.DAT file). Default setting: 1.0 *(Range: 0.01 to 2.5)*

Line - Field	PARM name and number	Description
L43-F4	`CBVT0`	BioVolume of organisms *(cols. 25-32)* It is the cumulative proportion of the BioVolume of spherical and cylindrical organisms. Used in the Izaurralde denitrification approach (see IDN in EPICCONT.DAT file). Default setting: 0.5 *(Range: 0.2 to 0.8)*

Detailed information on PARMs 82, 83, 84, 85, 86, 87, 88, 90, XKN50, XKN30, XKN10, and CBVT0 can be found in Izaurralde et al., 2017.

Figure 24. Example of the EPIC parameter file (PARM1102.DAT).

PARM1102.DAT - Notepad

File Edit Format View Help

```
   10.50  100.95
   50.10   95.95
    0.00    0.00
    1.05    3.95
   15.10  500.95
   33.75   67.99
   20.50   80.95
    1.10   10.99
   10.05   50.90
   20.10   50.95
    5.05  100.50
    1.80    3.99
    5.10   20.95
   10.10  100.95
    3.10   20.99
   10.10   50.75
  258.01  268.95
   25.05   75.90
  400.05  600.90
  100.01 1000.90
   10.70   40.95
    1.50    3.99
   25.10   60.95
    1.01    3.95
    1.25    5.95
   5.010  50.990

   75.01   95.99
     70.     30.
     1.0     2.0   0.500           0.500     0.1    0.99  10.000  50.000  100.00
  -100.0   2.500     0.0    0.50   5.000   0.150    0.00   0.100   0.100     1.0
 1000.00  0.0001     1.0    0.30    0.01    0.05    1.00    1.00    0.01     0.5
    1.00   0.050   0.001    1.00    1.00    0.20  100.00  0.0032  300.00
     0.1     1.5    1.00     0.5   0.003     0.1 .000548 .000012    0.85     0.0
     1.0    10.0    0.90     5.0     0.5     5.0     .05   500.0    10.0     2.0
     1.0    1.00  9000.0     0.5    0.05   0.001    6.00     2.0     0.1    3.00
    0.01    3.00    1.50    1.00    0.20   200.0  0.0001  0.0001     0.9     0.2
     1.7  0.0667     0.2    0.30   .0667     0.2  0.0075     2.0     1.0     1.0
     0.9     0.9     3.0                     0.5    0.70    0.95    0.60    0.70
    0.60    0.90    1.50    1.00
   0.044   31.00    0.51    1.00    1.00
   250.0    25.0     1.0     0.5
```

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EPIC print file (PRNT1102.DAT)

File format: 20 fields of 4 characters (integers)

The EPIC print file (PRNT1102.DAT) controls which output files will be printed by the model at the end of the simulation and, for some of the output files, which variable will be included in them. The file is divided in two main sections. The first section goes from line 1 to line 14. It is divided in subsections described later in this chapter, and controls which variables are printed in the output files available. The variables to be printed are selected by typing the ID code of the desired output variable. Within a subsection, a zero value (or a blank field) tells the model to disregard the variables that come after the zero. For instance, the sequence of ID numbers:

1 2 3 4 5

Prints the output variable with ID number 1, 2, 3, 4, and 5 while the sequences

1 2 3 0 5

or

1 2 3   5

Prints only variables with ID number 1, 2, and 3. The output variables available and the corresponding ID codes are listed in Table 16.

The second section of the EPIC print file (line 15 and 16) controls which output files will be available at the end of the simulation. In this section, each field corresponds to an output file and for each position, a value greater than zero indicates that the corresponding output files will be available at the end of the simulation. The list of output files available and the corresponding position in this section of the EPIC print file is reported in Table 17. For instance, the sequences

1 0 0 1 0

or

1 0 0 4 0

Prints the output files corresponding to position 1 and 4.

NOTE: command to print an output file is related to the position of the value greater than zero and not to the value itself. For instance, the sequences

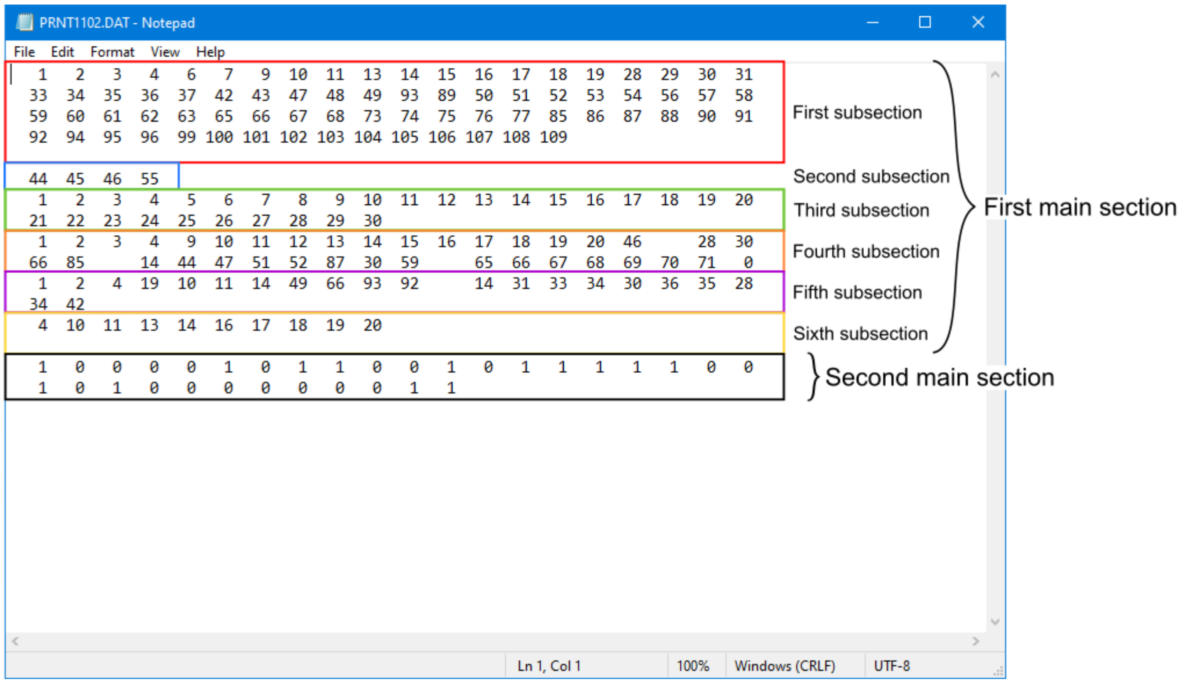
3 0 0 2 0

or

5 0 0 3 0

Will always print output files corresponding to position 1 and 4. See table 17 (column Line – Field) to identify the correct position in the EPIC print file to print each output file.

Figure 25. EPIC print file with the different sections used to define variables and output files to print at the end of the simulation.



The following subsections are included in the first main section of the EPIC print file.

Accumulated and average values

This subsection goes from line 1 to line 5. Up to 100 variables can be specified with up to 20 variables per line (format is four characters for each field). The output variables are selected by ID number (Table 16). A zero value or a blank indicates to ignore the remaining variables of this subsection. The ID numbers provided here affect the general output file (OUT).

Concentration variables

The second subsection is located on line 6 of the EPIC print file. Up to four concentration variables can be selected here. The following output variables will be printed in the monthly section of the OUT output file:

- 44 – QNO3: Nitrogen in runoff
- 45 – SNO3: Nitrogen in subsurface flow
- 46 – PRKN: Nitrogen in percolating water
- 55 – QAP: Phosphorus in runoff

State variables

The third subsection is located on lines 7 and 8 of the EPIC print file. Up to 40 variables can be selected here and the output variables are selected by ID number (see Table 15). A zero value or a blank indicates to ignore the remaining variables of this subsection The following variables can be selected:

Table 15. State variables available in EPIC1102 and relative ID numbers.

ID	Variable name	Description	Unit
1	`TNH3`	Total NH3 in soil profile	kg ha^{-1}
2	`TNO3`	Total NO3 in soil profile	kg ha^{-1}
3	`PLAB`	Total labile phosphorus in soil profile	kg ha^{-1}
4	`TSOK`	Total soluble potassium in soil profile	kg ha^{-1}
5	`SNOA`	Snow on soil surface (unit is mm of water equivalent)	mm
6	`RZSW`	Soil water in soil profile explored by root	mm
7	`WTBL`	Depth to water table	m
8	`GWST`	Groundwater storage	mm
9	`STDO`	Standing dead plant residue	Mg ha^{-1}
10	`RSD`	Crop residue in top soil layer	Mg ha^{-1}
11	`OCPD`	Organic carbon in plow layer depth (set with PARM(16))	kg ha^{-1}
12	`TOC`	Total organic carbon in soil profile	kg ha^{-1}
13	`LS`	Structural litter	kg ha^{-1}
14	`LM`	Metabolic litter	kg ha^{-1}
15	`LSL`	Lignin in structural litter	kg ha^{-1}
16	`LSC`	Carbon in structural litter	kg ha^{-1}
17	`LMC`	Carbon in metabolic litter	kg ha^{-1}
18	`LSLC`	Carbon in lignin of structural litter	kg ha^{-1}
19	`LSNC`	Nitrogen in lignin of structural litter	kg ha^{-1}

ID	Variable name	Description	Unit
20	BMC	Carbon in biomass pool	kg ha^{-1}
21	HSC	Carbon in slow humus pool	kg ha^{-1}
22	HPC	Carbon in passive humus pool	kg ha^{-1}
23	LSN	Nitrogen in structural litter	kg ha^{-1}
24	LMN	Nitrogen in structural litter	kg ha^{-1}
25	BMN	Nitrogen in biomass pool	kg ha^{-1}
26	HSN	Nitrogen in slow humus pool	kg ha^{-1}
27	HPN	Nitrogen in passive humus pool	kg ha^{-1}
28	TWN	Total nitrogen in litter and organic pools	kg ha^{-1}
29	SALT	Salt in soil profile	kg ha^{-1}
30	TNO2	Total NO2 in soil profile	kg ha^{-1}

Daily output variables

The fourth subsection allows the user to select variables printed at daily time scale. This subsection goes from line 9 to line 10 and up to 40 variables can be selected. The output variables are selected by ID number (see Table 16). A zero value or a blank indicates to ignore the remaining variables of this subsection.

Annual output variables (accumulated and average)

The fifth subsection allows the user to select variables printed at an annual time scale. The output values can be annual average values (e.g., air temperature) or cumulative value (e.g., precipitation). This subsection goes from line 11 to line 12 and up to 40 variables can be selected. The output variables are selected by ID number (see Table 16). A zero value or a blank indicates to ignore the remaining variables of this subsection.

Monthly FLIPSIM output variables (accumulated and average)

The sixth subsection allows the user to select variables printed in the monthly FLIPSIM output file. This subsection goes from line 13 to line 14 and up to 40 variables can be selected. The output variables are selected by ID number (see Table 16). A zero value or a blank indicates to ignore the remaining variables of this subsection.

Output variables available in EPIC1102

The variables reported in Table 16 can be selected by the user for printing. To select a variable, the corresponding ID number must be added to the EPIC print file

Table 16. Output variables available in EPIC1102 and relative ID numbers.

ID	Variable name	Description	Unit
1	TMX	Maximum air temperature	°C
2	TMN	Minimum air temperature	°C
3	RAD	Solar radiation	MJ m^{-2}
4	PRCP	Precipitation	mm
5	SNOF	Snow fall	mm
6	SNOM	Snow melt	mm
7	WSPD	Wind velocity	m sec^{-1}
8	RHUM	Relative humidity	
9	VPD	Vapor pressure deficit	kPa
10	PET	Potential evapotranspiration	mm
11	ET	Evapotranspiration	mm
12	PEP	Potential transpiration	mm
13	EP	Transpiration	mm
14	Q	Surface runoff	mm
15	CN	SCS runoff curve number	
16	SSF	Lateral subsurface flow	mm

ID	Variable name	Description	Unit
17	PRK	Percolation below the root zone (added to the ground water storage)	mm
18	QDRN	Water flow from a drainage system	mm
19	IRGA	Irrigation water applied	mm
20	QIN	Inflow to the root zone from the water table	mm
21	TLGE	Lagoon evaporation	mm
22	TLGW	Water wash to lagoon	mm
23	TLGQ	Runoff to lagoon	mm
24	TLGF	Lagoon overflow	mm
25	LGIR	Irrigation water from a lagoon	mm
26	LGMI	Manure input to lagoon	kg ha^{-1}
27	LGMO	Manure output from lagoon	kg ha^{-1}
28	EI	Rainfall energy factor	
29	CVF	Average water erosion / crop management factor	
30	USLE	Soil loss from water erosion using USLE	Mg ha^{-1}
31	MUSL	Soil loss from water erosion using MUSLE	Mg ha^{-1}
32	AOF	Soil loss from water erosion using Onstad-Foster	Mg ha^{-1}
33	MUSS	Soil loss from water erosion using equation developed by fitting small watershed data (no channel erosion)	Mg ha^{-1}
34	MUST	Soil loss from water erosion using equation theoretically developed from sediment concentration bases	Mg ha^{-1}
35	RUS2	Soil loss from water erosion using RUSLE2	Mg ha^{-1}
36	RUSL	Soil loss from water erosion using RUSLE	Mg ha^{-1}
37	RUSC	Soil loss from water erosion using Modified RUSLE	Mg ha^{-1}
38	WK1	Wind erosion soil erodibility factor	
39	RHTT	Ridge height	mm
40	RRUF	Random roughness of soil	
41	RGRF	Wind erosion ridge roughness factor	

ID	Variable name	Description	Unit
42	YW	Soil loss from wind erosion	Mg ha^{-1}
43	YON	Nitrogen in sediment	kg ha^{-1}
44	QNO3	Mineral nitrogen lost with runoff	kg ha^{-1}
45	SNO3	Mineral nitrogen in lateral subsurface flow	kg ha^{-1}
46	VNO3	Mineral nitrogen in percolated water	kg ha^{-1}
47	NMN	Net amount of nitrogen mineralized from stable organic matter. NMN = GMN – N immobilized	kg ha^{-1}
48	GMN	Gross amount of nitrogen mineralized	kg ha^{-1}
49	DN	Nitrogen loss by denitrification	kg ha^{-1}
50	NFIX	Nitrogen fixed by leguminous plants	kg ha^{-1}
51	NITR	Nitrogen nitrified (nitrification)	kg ha^{-1}
52	AVOL	Nitrogen volatilization	kg ha^{-1}
53	DRNN	Mineral nitrogen in drainage flow	kg ha^{-1}
54	YP	Phosphorus in sediment	kg ha^{-1}
55	QAP	Phosphorus in runoff	kg ha^{-1}
56	MNP	Phosphorus mineralized	kg ha^{-1}
57	PRKP	Phosphorus in percolated water	kg ha^{-1}
58	ER	Enrichment ratio	mm
59	FNO	Organic nitrogen fertilizer applied	kg ha^{-1}
60	FNO3	Nitrate nitrogen fertilizer applied	kg ha^{-1}
61	FNH3	Ammonium nitrogen fertilizer applied	kg ha^{-1}
62	FPO	Organic phosphorus fertilizer applied	kg ha^{-1}
63	FPL	Mineral phosphorus fertilizer applied	kg ha^{-1}
64	FSK	Potassium fertilizer applied	kg ha^{-1}
65	FCO	Organic carbon in fertilizer	kg ha^{-1}
66	LIME	Limestone applied ($CaCO_3$ equivalent)	Mg ha^{-1}

ID	Variable name	Description	Unit
67	TMP	Soil temperature in the second layer	°C
68	SW10	Water content of the first soil layer	mm
69	SLTI	Salt in irrigation water	kg ha^{-1}
70	SLTQ	Salt in runoff	kg ha^{-1}
71	SLTS	Salt in lateral subsurface flow	kg ha^{-1}
72	SLTF	Salt in fertilizer	kg ha^{-1}
73	RSDC	Carbon contained in crop residue	kg ha^{-1}
74	RSPC	CO2 respiration	kg ha^{-1}
75	CLCH	Soluble carbon in percolated water	kg ha^{-1}
76	CQV	Carbon in runoff	kg ha^{-1}
77	YOC	Carbon in sediment	kg ha^{-1}
78	YEFK	Potassium loss by erosion in the topsoil layer	kg ha^{-1}
79	QSK	Potassium in runoff	kg ha^{-1}
80	SSK	Potassium in subsurface later flow	kg ha^{-1}
81	VSK	Potassium in percolated water	kg ha^{-1}
82	SLTV	Salt in percolated water	
83	MUSI	Soil loss from water erosion using modified MUSLE	Mg ha^{-1}
84	IRDL	Irrigation distribution losses	mm
85	HMN	Nitrogen mineralized from stable organic matter	kg ha^{-1}
86		Not used	
87	NIMO	Nitrogen immobilization	kg ha^{-1}
88	FALF	Leaf fall	kg ha^{-1}
89	DN2	Loss of dinitrogen gas (available only with Izaurralde denitrification approach; IDN = 3 or IDN = 4)	kg ha^{-1}
90		Not used	
91		Not used	

ID	Variable name	Description	Unit
92	FULU	Fuel used	L ha^{-1}
93	DN2O	Nitrous oxide loss	kg ha^{-1}
94	FO2	Surface flux of O_2	kg ha^{-1}
95	FCO2	Surface flux of CO_2	kg ha^{-1}
96		Not used	
97	BURC	Carbon loss from burning plant residue or forest	kg ha^{-1}
98	BURN	Nitrogen loss from burning plant residue or forest	
99	NPPC	Net primary productivity (carbon) VAR(99) = dry matter × 420.0	kg ha^{-1}
100	NEE	Net ecosystem exchange VAR(100) = VAR(78) – VAR(99)	kg ha^{-1}
101	FN2O	N_2O emission estimated with Izaurralde approach (see variable IDN in EPICCONT.DAT)	kg ha^{-1}
102	SNO2	Total NO_2 in lateral subsurface flow	kg ha^{-1}
103	SN2O	Total N_2O in lateral subsurface flow	kg ha^{-1}
104	VN2O	Total NO_2 in percolated water	kg ha^{-1}
105	VNO2	Total N_2O in percolated water	kg ha^{-1}
106	QNO2	Total NO_2 in runoff	kg ha^{-1}
107	QN2O	Total N_2O in runoff	kg ha^{-1}
108	UNO3	Plant nitrogen uptake in the NO_3 form	kg ha^{-1}
109	UNH3	Plant nitrogen uptake in the NH_3 form	kg ha^{-1}
110	RSSF	Return subsurface flow	mm
111	DPRK	Deep percolation (water percolated from the ground water)	mm
112	RSFN	Nitrogen in return subsurface flow	kg ha^{-1}
113	DPKN	Nitrogen in deep percolated water	kg ha^{-1}
114	DRNP	Phosphorus in deep percolated water	kg ha^{-1}

EPIC1102 output files

The output files printed by the EPIC model can be selected by adding the output file ID number on lines 15 and 16 of the EPIC print file.

Table 17. List of output files available in EPIC1102 with relative ID code and columns occupied by each field.

Line - Field	ID number	Output file extension	Description	Columns
L15-F1	1	OUT	General, standard output file	1-4
L15-F2	2	ACM	Annual CROPMAN output file	5-8
L15-F3	3	SUM	Average annual summary output file	9-12
L15-F4	4	DHY	Daily hydrology output file	13-16
L15-F5	5	DPS	Daily pesticide output file	17-20
L15-F6	6	MFS	Monthly FLIPSIM output file	21-24
L15-F7	7	MPS	Monthly pesticide output file	25-28
L15-F8	8	ANN	Annual output file	29-32
L15-F9	9	SOT	Soil characteristics at the end of the simulation. (It can be used as input file in following simulation)	33-36
L15-F10	10	DTP	Daily soil temperature output file	37-40
L15-F11	11	MCM	Monthly CROPMAN output file	41-44
L15-F12	12	DCS	Daily crop stress output file	45-48
L15-F13	13	SCO	Operation cost summary output file	49-52
L15-F14	14	ACN	Annual soil organic C and N output file	52-56
L15-F15	15	DCN	Daily soil organic C and N output file	57-60
L15-F16	16	SCN	Summary soil organic C and N output file	61-64
L15-F17	17	DGN	Daily general output file	65-68
L15-F18	18	DWT	Daily soil water in control section and 0.5 m soil temperature output file	69-72
L15-F19	19	ACY	Annual crop data output file	73-76
L15-F20	20	ACO	Annual cost output file	77-80

Line - Field	ID number	Output file extension	Description	Columns
L16-F1	21	DSL	Daily soil output file	1-4
L16-F2	22	MWC	Monthly water and nitrogen cycle output file	5-8
L16-F3	23	ABR	Annual biomass and root weight output file	9-12
L16-F4	24	ATG	Annual tree growth output file	13-16
L16-F5	25	MSW	Monthly output to SWAT file	17-20
L16-F6	26	APS	Annual pesticide output file	21-24
L16-F7	27	DWC	Daily water cycle output file	25-28
L16-F8	28	DHS	Daily hydrology and soil output file	29-32
L16-F9	29	DGZ	Daily grazing output file	33-36
L16-F10	30	DNC	Daily nitrogen and carbon C. Izaurralde output file	37-40
L16-F11	31	ASL	Annual soil output file	41-44
L16-F12	32	DDN	Daily denitrification	45-48
L16-F13	33			49-52
L16-F14	34			52-56
L16-F15	35			57-60
L16-F16	36			61-64
L16-F17	37			65-68
L16-F18	38			69-72
L16-F19	39			73-76
L16-F20	40			77-80

INDIVIDUAL EPIC OUTPUT FILES

The following section includes a description of all the output files (selected using the EPIC print file) that can be printed by the EPIC model.

OUT – Standard Output File (ID 1)

This output file contains several information related to the simulation and can be considered as a log of the simulation. The first part of this file is organized into several sections containing information on the simulation. The first section provides information on the output variables available and their ID number. The following section (miscellaneous parameters) reports the values used in the simulation for each parameter included in the EPIC parameter file (PARM1102).
The weather section contains information on the weather data used for the simulation.
A large section with general information follows the weather data section. It contains general information on the setting of the EPIC model for the current simulation. It provides information on the simulated field/area, the method used to simulate evapotranspiration, soil erosion, soil organic carbon and nitrogen dynamics, etc.
The next section contains data on the soil used in the simulation. General information on the soil and specific physical and chemical data by soil layer are provided.
Another important section is the one that summarizes the management data used in the simulation. In this section, general information on the management (e.g., manual or automatic irrigation or fertilization, grazing information, etc.) is provided. Then, detailed information on each operation included in the management is reported.
The last section with data related to the model setup is the crop parameters section where the values of the crop parameters used in the simulation are reported.

The rest of the OUT file includes output at different time scale depending on the setting (IPD in the EPIC control file) selected by the user. At the end of the OUT file, average values and balances for water carbon, nitrogen, phosphorus, potassium, and salt for the entire simulation are provided.

Balances for water, nitrogen (N), carbon, (C), phosphorus (P), potassium (K), and salt are provided toward the end of the OUT file. These balances can be used to assess the general quality of the simulation. A simulation without errors should result in balances close to zero. In all the balances, the variable PER is the percent error of the balance while DF is the error in the balance. Both of them should be close to zero.
The variables used in the water balance are the following.

- BSW: soil water content at the beginning of the simulation
- PCP: precipitation
- Q: surface runoff
- ET: evapotranspiration
- PRK: percolation below the root zone
- SSF: subsurface flow

- IRG: irrigation
- IRDL: irrigation distribution loss
- SNO: snow
- QIN: inflow to the root zone from the water table
- FSW: soil water content at the end of the simulation

The variables used in the nitrogen balance are the following.

- BTOT: total nitrogen at the beginning of the simulation
- PCP: nitrogen deposition from precipitation
- Y: nitrogen loss with sediment
- QNO3: NO_3 loss with surface runoff
- SNO3: NO_3 in subsurface flow
- VNO3: NO_3 loss with percolating water
- QNO2: NO2 loss in surface runoff (for Izaurralde approach; see IDN in EPIC control file)
- SNO2: NO_2 loss in subsurface flow (for Izaurralde approach; see IDN in EPIC control file)
- VNO2: NO2 loss in percolating water (for Izaurralde approach; see IDN in EPIC control file)
- QN2O: N2O in surface runoff (for Izaurralde approach; see IDN in EPIC control file)
- SN2O: N2O in subsurface flow (for Izaurralde approach; see IDN in EPIC control file)
- VN2O: N2O in percolating water (for Izaurralde approach; see IDN in EPIC control file)
- DNIT: nitrogen loss with denitrification
- YLD: nitrogen removed with crop yield
- VOL: nitrogen volatilization
- FNO3: mineral nitrogen (NO3) from fertilization
- FNH3: mineral nitrogen (NH3) from fertilization
- FIX: nitrogen fixation form legumes
- FORG: nitrogen from organic fertilizer
- BURN: nitrogen loss with burning operation
- FN2O: total N2O losses (only with the Izaurralde approach; see IDN in EPIC control file)
- FTOT: total nitrogen at the end of the simulation

The variables used in the carbon balance are the following.

- BTOT: total carbon at the beginning of the simulation
- Y: carbon losses with sediment
- PRK: carbon loss with percolating water
- Q: carbon loss in surface runoff
- RSPC: soil respiration
- TFOC: carbon input from organic fertilizer
- NPPC: net primary productivity
- YLDC: carbon removed with crop yield
- BURN: carbon loss with burning operation
- FTOT: carbon at the end of the simulation

The variables used in the phosphorus balance are the following.

- BTOT: phosphorus at the beginning of the simulation
- Y: phosphorus loss with sediment
- Q: phosphorus loss with surface runoff
- PRK: phosphorus loss with percolating water
- YLD: phosphorus removed with crop yield
- FPML: mineral phosphorus from fertilization
- FPO: organic phosphorus form organic fertilization
- ETOT: phosphorus content at the end of the simulation

The variables used in the potassium balance are the following.

- BTOT: potassium at the beginning of the simulation
- Y: potassium loss with sediment
- Q: potassium loss with surface runoff
- SSF: potassium loss with subsurface flow
- PRK: potassium loss with percolating water
- YLD: potassium removed with crop yield
- FKM: potassium from fertilization
- ETOT: potassium content at the end of the simulation

The variables used in the carbon balance are the following.

- BTOT: salt at the beginning of the simulation
- IRR: salt added with irrigation water
- FERT: salt added with fertilizers
- PRK: salt removed with percolating water
- SSF: salt in subsurface flow water
- Q: salt in surface runoff
- FTOT: salt at the end of the simulation

A summary table for the entire simulation with average monthly and annual values is available at the end of the OUT file.

Variable printed in the OUT file can be selected from the section for accumulated and average values (first subsection, line 1-5), concentration variable (second subsection, line 6), daily outputs (fourth subsection, line 9-10), and annual outputs (fifth subsection, line 11-12).

ACM – Annual CROPMAN output file (ID 2)

The ACM output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Variables included in the ACM file are listed in the following table.

Variable name	Description	Unit
IYR	Year of simulation	
IRLX	Number of years of the simulation	
PRCP	Precipitation	mm
PET	Potential evapotranspiration	mm
ET	Evapotranspiration	mm
Q	Surface runoff	mm
SSF	Subsurface lateral flow	mm
PRK	Percolation below root zone	mm
CVF	Soil cover factor	
MUSS	Water-drive soil erosion estimated with MUSS approach (DRV = 3)	$Mg\ ha^{-1}$
YW	Wind-driven soil erosion	$Mg\ ha^{-1}$
GMN	Gross nitrogen mineralization	$kg\ ha^{-1}$
NMN	Net nitrogen mineralization	$kg\ ha^{-1}$
NFIX	Nitrogen fixation from legumes	$kg\ ha^{-1}$
NITR	Nitrification	$kg\ ha^{-1}$
AVOL	Nitrogen volatilization	$kg\ ha^{-1}$
DN	Denitrification	$kg\ ha^{-1}$
YON	Nitrogen loss with sediment	$kg\ ha^{-1}$
QNO3	Nitrogen loss with surface runoff	$kg\ ha^{-1}$
SNO3	Nitrogen loss with subsurface lateral flow	$kg\ ha^{-1}$
VNO3	Nitrogen loss with percolation	$kg\ ha^{-1}$
MNP	Phosphorus mineralized	$kg\ ha^{-1}$
YP	Phosphorus loss with sediment	$kg\ ha^{-1}$
QAP	Phosphorus (labile) loss with surface runoff	$kg\ ha^{-1}$

Variable name	Description	Unit
PRKP	Phosphorus (labile) loss with percolation	kg ha^{-1}
LIME	Total lime applied	kg ha^{-1}
OCPD	Organic carbon in plow layer depth (set with PARM(16))	kg ha^{-1}
TOC	Total organic carbon in soil profile	kg ha^{-1}
APBC	Labile phosphorus content in plow layer	g Mg^{-1}
TAP	Total labile phosphorus in soil profile	kg ha^{-1}
ZNO3	Total nitrate in soil profile	kg ha^{-1}

SUM – Average Annual Summary Output file (ID 3)

The SUM output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Variables included in the SUM file are listed in the following table.

Variable name	Description	Unit
PRCP	Precipitation	mm
PET	Potential evapotranspiration	mm
ET	Evapotranspiration	mm
Q	Surface runoff	mm
SSF	Subsurface lateral flow	mm
PRK	Percolation below root zone	mm
CVF	Soil cover factor	
	Water-driven soil erosion estimated with approach selected by the user (DRV in EPIC control file). The name of the variable changes depending on the approach selected.	Mg ha^{-1}
YW	Wind-driven soil erosion	Mg ha^{-1}
GMN	Gross nitrogen mineralization	kg ha^{-1}
NMN	Net nitrogen mineralization	kg ha^{-1}
NFIX	Nitrogen fixation from legumes	kg ha^{-1}
NITR	Nitrification	kg ha^{-1}

Variable name	Description	Unit
`AVOL`	Nitrogen volatilization	kg ha^{-1}
`DN`	Denitrification	kg ha^{-1}
`YON`	Nitrogen loss with sediment	kg ha^{-1}
`QNO3`	Nitrogen loss with surface runoff	kg ha^{-1}
`SNO3`	Nitrogen loss with subsurface lateral flow	kg ha^{-1}
`VNO3`	Nitrogen loss with percolation	kg ha^{-1}
`MNP`	Phosphorus mineralized	kg ha^{-1}
`YP`	Phosphorus loss with sediment	kg ha^{-1}
`QAP`	Phosphorus (labile) loss with surface runoff	kg ha^{-1}
`PRKP`	Phosphorus (labile) loss with percolation	kg ha^{-1}
`YOC`	Carbon loss with sediment	kg ha^{-1}
The following information for pesticide is printed for 10 pesticides. Zeroes and empty values are used if less than 10 pesticides are applied.		
`PSTN`	Pesticide name	
`APRT`	Actual amount of pesticide applied. It is calculated as pesticide application rate (from OPV1 in EPIC management file) and the pesticide application efficiency (see HE in TILLCOM.DAT)	g ha^{-1}
The following information for crop is printed for 10 crops. Fields will remain empty if less than 10 crops are simulated.		
`CPNM`	Crop name	
`YLDG`	Grain yield	Mg ha^{-1}
`YLDF`	Forage yield (if ORHI in EPIC tillage and equipment list > 0)	Mg ha^{-1}
`BIOM`	Total plant biomass (above and below ground)	Mg ha^{-1}
`YLN`	Nitrogen removed with yield	kg ha^{-1}
`YLP`	Phosphorus removed with yield	kg ha^{-1}
`FTN`	Nitrogen applied with fertilization (mineral + organic)	kg ha^{-1}
`FTP`	Phosphorous applied with fertilization (mineral + organic)	kg ha^{-1}
`IRGA`	Irrigation applied	mm

Variable name	Description	Unit
IRDL	Irrigation water loss in irrigation system (controlled by EFM in EPIC tillage and equipment list)	mm
WUEF	Water use efficiency (yield gran and forage / growing season ET)	kg mm^{-1}
CAW	Crop available water (soil water content at planting + growing season rainfall – runoff). Irrigation is not considered.	mm
CRF	Growing season rainfall	mm
CQV	Growing season runoff	mm
THU	Total heat units	°C
PHU	Potential heat units	°C
COST	Total cost of production	$ ha^{-1}
COOP	Operation cost	$ ha^{-1}
RETN	Return from yield (yield grain × price grain + yield forage × price forage)	$ ha^{-1}
PSTF	Pest damage factor (fraction of yield remaining after pest damage)	
WS	Water stress	Days
NS	Nitrogen stress	Days
PS	Phosphorus stress	Days
KS	Potassium stress	Days
TS	Temperature stress (low and high temperature)	Days
AS	Aeration stress (waterlogged soil)	Days
SS	Salt stress	Days
BD	Bulk density stress	Days
ALSA	Aluminum saturation stress	Days
SRT	Soil temperature stress	Days

DHY – Daily Hydrology Output file (ID 4)

The DHY output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Variables included in the DHY file are listed in the following table.

Variable name	Description	Unit
Y	Year	
M	Month	
D	Day	
CN	Curve number	
RAIN	Precipitation	mm
Q	Surface runoff	mm
TC	Time of concentration of the watershed	h
QP	Peak surface runoff rate	mm h^{-1}
DUR	Rainfall duration	h
ALTC	Maximum rainfall of duration TC / total storm rainfall	
AL5	Maximum 0.5 hour rainfall / total storm rainfall	

DPS – Daily Pesticide Output file (ID 5)

The DPS output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Variables included in the DPS file are listed in the following table. Values are printed only if at least one pesticide application is simulated.

Variable name	Description	Unit
Y	Year	
M	Month	
D	Day	
RT#	Year of simulation	
PSTN	Name of pesticide	
PAPL	Amount of pesticide applied	g ha^{-1}
PSRO	Pesticide in surface runoff	g ha^{-1}

Variable name	Description	Unit
PLCH	Pesticide in percolating water	g ha^{-1}
PSSF	Pesticide in lateral subsurface flow	g ha^{-1}
PSED	Pesticide transported by sediment	g ha^{-1}
PDGF	Pesticide degradation from foliage	g ha^{-1}
PDGS	Pesticide degradation from soil	g ha^{-1}
PFOL	Pesticide on plant foliage	g ha^{-1}
PSOL	Pesticide present in soil	g ha^{-1}
PDRN	Pesticide in drainage system outflow	g ha^{-1}
Q	Surface runoff	mm
SSF	Lateral subsurface flow	mm
PRK	Percolation below root zone	mm
ROCONC	Pesticide concentration in surface runoff and lateral subsurface flow	ppb

MFS – Monthly FLIPSIM Output file (ID 6)

The MFS output file is printed with a mix of formats. The user can select some of the variables printed in this file using lines 13 and 14 of the EPIC print file. Before and after the output variables are selected by the user, the model prints the following variables.

Variable name	Description	Unit
Y	Year	
M	Month	
RT#	Year of simulation	
	The following variables are printed after the variables selected by the user	
RZSW	Soil water in soil profile explored by root	mm
WTBL	Depth to water table	m
GWST	Groundwater storage	mm

MPS – Monthly Pesticide Output file (ID 7)

The MPS output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. The output variables are printed for each pesticide included in the simulation and for each run/simulation executed as indicated by the variables IRUN (number of run if more than one is included in EPICRUN file), IRO (number of run if multiple runs are listed in the MLRN1102 file), IGN and year number of the simulation (RT#).

Variable name	Description	Unit
PAPL	Amount of pesticide applied	g ha^{-1}
PSRO	Pesticide in surface runoff	g ha^{-1}
PLCH	Pesticide in percolating water	g ha^{-1}
PSSF	Pesticide in lateral subsurface flow	g ha^{-1}
PSED	Pesticide transported by sediment	g ha^{-1}

ANN – Annual Output file (ID 8)

The ANN output file is printed with a mix of formats. The user can select some of the variables printed in this file using lines 11 and 12 of the EPIC print file. Two variables (AP15 and PMTE) are always printed in front of the output variables selected by the user.

Variable name	Description	Unit
RUN	Number of run if more than one is included in EPICRUN file	
YR	Year	
AP15	Labile concentration in topsoil to a depth set by PARM(16)	ppm
PMTE	Aboveground plant biomass (includes standing dead biomass)	Mg ha^{-1}

SOT – Ending soil table Output file (ID 9)

The SOT output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. The variables printed in the SOT file are the same as the SOL input file with up to 15 columns (one for each soil layer) populated with values. As for the input soil file, the first row is a description, the second and third rows include general soil data, rows from 4 to 51 include data for different soil variables. This is a special output file that can be used as an input file for following simulations. For instance, a first simulation can be set to initialize the soil organic carbon and nitrogen pools and the EPIC print file can be set to print the SOT output file. At the end of this simulation, the SOT file will have the characteristics of the soil at the end of the initialization period and the SOT file can be used in another simulation that will begin with the soil generated with the previous initialization.

DTP – Daily Soil Temperature Output file (ID 10)

The DTP output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Along with the temperature at the center of each soil layer, the DTP file includes data on the damping depth in meters and the temperature of the soil surface. All the temperatures are reported in Celsius degrees (°C).

MCM – Monthly CROPMAN Output file (ID 11)

The MCM output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Variables included in the DPS file are listed in the following table.

Variable name	Description	Unit
Y	Year	
M	Month	
RT#	Year of simulation	
CPNM	Crop name	
WS	Water stress	Days
NS	Nitrogen stress	Days
PS	Phosphorus stress	Days
KS	Potassium stress	Days
TS	Temperature stress (low and high temperature)	Days
AS	Aeration stress (waterlogged soil)	Days
SS	Salt stress	Days
RZSW	Soil water in soil profile explored by root	mm
PRCP	Precipitation	mm
ET	Evapotranspiration	mm
Q	Surface runoff	mm
PRK	Percolation below root zone	mm
SSF	Lateral subsurface flow	mm

DCS – Daily Crop Stress Output file (ID 12)

The DCS output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Output variables are printed only if a plant is actively growing during the simulation. For instance, if no plant is growing from January to May, values will be printed starting in May. Variables included in the DPS file are listed in the following table.

Variable name	Description	Unit
Y	Year	
M	Month	
D	Day	
RT#	Year of simulation	
CPNM	Crop name	
HUI	Heat unit index	
AJHI	Adjusted harvest index based on crop maturity	
LAI	Leaf Area Index	
BIOM	Total plant biomass (above and below ground)	Mg ha^{-1}
RW	Root weight	Mg ha^{-1}
STL	Standing live biomass (aboveground)	Mg ha^{-1}
HI	Harvest index adjusted considering crop maturity and water stress	
YLDX	Potential crop yield (calculated as HI × STL) if harvested on current date	Mg ha^{-1}
YLDF	Forage yield	Mg ha^{-1}
UNO3	Plant nitrogen uptake	kg ha^{-1}
NPP	Net Primary Productivity (daily biomass production × 420)	kg C ha^{-1}
NEE	Net Ecosystem Exchange (RSPC – NPP)	kg C ha^{-1}
WS	Water stress	Days
NS	Nitrogen stress	Days
PS	Phosphorus stress	Days
KS	Potassium stress	Days
TS	Temperature stress (low and high temperature)	Days

Variable name	Description	Unit
AS	Aeration stress (waterlogged soil)	Days
SS	Salt stress	Days
RW1 – RW15	Root weight in soil layer 1 to soil layer 15	Mg ha^{-1}

SCO – Summary Operation Cost Output file (ID 13)

The SCO output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Each operation is printed on one line and different variables are arranged in columns. Variables included in the DPS file are listed in the following table.

Variable name	Description	Unit
Y	Year of the rotation	
M	Month	
D	Day	
OP	Name of the operation	
CROP	Name of the crop	
MT#	ID of the item applied (fertilizer or pesticide). Comes from JX(7) in the EPIC management file and matches the ID number in FERTCOM.DAT and PESTCOM.DAT files.	
IHC	Operation code. See IHC in TILLCOM.DAT file	
EQ	Equipment ID number. Comes from JX(4) in the EPIC management file and matches the ID number in TILLCOM.DAT file.	
TR	Tractor ID number. Comes from JX(5) in the EPIC management file and matches the ID number of tractors in TILLCOM.DAT file.	
COTL	Total cost	\$ ha^{-1}
COOP	Operation cost	\$ ha^{-1}
MTCO	Material cost (seed, fertilizer, pesticide, water)	\$ ha^{-1}
MASS	Amount applied	kg ha^{-1}
FUEL	Fuel consumed for the operation	L ha^{-1}

ACN – Annual Soil Organic C and N Output file (ID 14)

The ACN output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Data in this output file is printed at the beginning of the simulation and at the end of each year of the simulation. The ACN output file includes data for 10 soil layers. The header has the original number of the soil layer before splitting operation occurs. Therefore, layers deriving from the same original layer have the same layer ID number. Variables included in the ACN file are listed in the following table.

Variable name	Description	Unit
`Depth`	Depth to the bottom of the soil layer	m
`BD 33kpa`	Bulk density	Mg m^3
`SAND`	Sand content	%
`SILT`	Silt content	%
`CLAY`	Clay content	%
`ROCK`	Coarse fragment fraction	%
`WLS`	Structural litter	kg ha^{-1}
`WLM`	Metabolic litter	kg ha^{-1}
`WLSL`	Lignin content of structural litter	kg ha^{-1}
`WLSC`	Carbon content of structural litter	kg ha^{-1}
`WLMC`	Carbon content of metabolic litter	kg ha^{-1}
`WLSLC`	Carbon content of lignin of structural litter	kg ha^{-1}
`WLSLNC`	Nitrogen content of lignin of structural litter	kg ha^{-1}
`WBMC`	Carbon content of biomass organic pool	kg ha^{-1}
`WHSC`	Carbon content of slow humus pool	kg ha^{-1}
`WHPC`	Carbon content of passive humus pool	kg ha^{-1}
`WOC`	Organic carbon	kg ha^{-1}
`WLSN`	Nitrogen content of structural litter	kg ha^{-1}
`WLMN`	Nitrogen content of metabolic litter	kg ha^{-1}
`WBMN`	Nitrogen content of biomass pool	kg ha^{-1}

Variable name	Description	Unit
WHSN	Nitrogen content of slow humus pool	kg ha^{-1}
WHPN	Nitrogen content of passive humus pool	kg ha^{-1}
WON	Organic nitrogen	kg ha^{-1}
CFEM	Carbon emission	kg ha^{-1}

DCN – Daily Soil Organic C and N Output file (ID 15)

The DCN output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Data in this output file are printed at the beginning of the simulation (beginning of day 1) and at the end of each day. The DCN output file includes data for 10 soil layers. The header has the original number of the soil layer before splitting operation occurs. Therefore, layers deriving from the same original layer have the same layer ID number. Variables included in the DCN file are listed in the following table.

Variable name	Description	Unit
Depth	Depth to the bottom of the soil layer	m
SW	Soil water content	m/m
TEMP	Soil temperature	°C
RSD	Crop residue	Mg ha^{-1}
BIOMIX	Biological mixing (meters of soil mixed by biological activity)[1]	m
CO2 LOSS	CO_2 losses	kg C ha^{-1}
NET MN	Net mineralization	kg N ha^{-1}
DN2G	N_2 generated during a day[2]	kg N ha^{-1}

[1]BIOMIX is reported for the entire soil profile and not for each individual soil layer.
[2]DN2G output is available only if the Cezar Izaurralde denitrification approach (IDN=3 or IDN=4) is selected by the user. It is reported for the entire soil profile and not for each individual soil layer.

SCN – Summary Soil Organic C and N Output file (ID 16)

The SCN output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. The SCN output file includes data for up to 15 soil layers if available. The header has the original number of the soil layer before splitting operation occurs. Therefore, layers deriving from the same original layer have the same layer ID number. Variables included in the SCN file are listed in the following table.

Variable name	Description	Unit
Z	Depth to the bottom of the soil layer	m
SWF	Soil water factor	m/m
TEMP	Soil temperature	°C
SWTF	Combined soil water and temperature factor	
TLEF	Tillage factor	
SPDM	Nitrogen supply / demand ratio	
RSDC	Carbon input in residue	kg ha^{-1}
RSPC	Carbon respiration	kg ha^{-1}
RNMN	Net nitrogen mineralization	kg ha^{-1}
DNO3	Change in soil mineral nitrogen	kg ha^{-1}
HSC0	Initial carbon content of slow humus pool	kg ha^{-1}
HSCF	Final carbon content of slow humus pool	kg ha^{-1}
HPC0	Initial carbon content of passive humus pool	kg ha^{-1}
HPCF	Final carbon content of passive humus pool	kg ha^{-1}
LSC0	Initial carbon content of structural litter	kg ha^{-1}
LSCF	Final carbon content of structural litter	kg ha^{-1}
LMC0	Initial carbon content of metabolic litter	kg ha^{-1}
LMCF	Final carbon content of metabolic litter	kg ha^{-1}
BMC0	Initial carbon content of biomass organic pool	kg ha^{-1}
BMCF	Final carbon content of biomass organic pool	kg ha^{-1}
WOC0	Initial total soil organic carbon	kg ha^{-1}
WOCF	Final total soil organic carbon	kg ha^{-1}

Variable name	Description	Unit
DWOC	Change in total soil organic carbon	kg ha^{-1}
HSN0	Initial nitrogen content of slow humus pool	kg ha^{-1}
HSNF	Final nitrogen content of slow humus pool	kg ha^{-1}
HPN0	Initial nitrogen content of passive humus pool	kg ha^{-1}
HPNF	Final nitrogen content of passive humus pool	kg ha^{-1}
LSN0	Initial nitrogen content of structural litter	kg ha^{-1}
LSNF	Final nitrogen content of structural litter	kg ha^{-1}
LMN0	Initial nitrogen content of metabolic litter	kg ha^{-1}
LMNF	Final nitrogen content of metabolic litter	kg ha^{-1}
BMN0	Initial nitrogen content of biomass pool	kg ha^{-1}
BMNF	Final nitrogen content of biomass pool	kg ha^{-1}
WON0	Initial total soil organic nitrogen	kg ha^{-1}
WONF	Final total soil organic nitrogen	kg ha^{-1}
DWON	Change in total soil organic nitrogen	kg ha^{-1}
C/N0	Initial C/N ratio	
C/NF	Final C/N ratio	

DGN – Daily General Output file (ID 17)

The DGN output file is printed with a mix of formats. The user can select some of the variables printed in this file using lines 9 and 10 of the EPIC print file. The variables selected by the user are printed at the beginning of the DGN file. Fixed variables always included in the DGN file are listed in the following table.

ATTENTION: If more than one crop is growing in the same field at the same time, crop data for only one crop will be printed on each day. If crop A and crop B are growing in the same field at the same time, variables for crop A will be printed on one day and variables for crop B will be printed for the next day. We plan to edit the code to print crop variables for multiple crops at daily time scale in a dedicated output file.

Variable name	Description	Unit
Y	Year	
M	Month	
D	Day	
PDSW	Ratio PDSW / FCSW [1]	
	Up to 40 output variables selected by the user are printed here	
ZNH3	NH_3-N content of the soil profile	kg N ha^{-1}
ZNO3	NO_3-N content of the soil profile	kg N ha^{-1}
NO31	NO_3-N content of first soil layer	kg N ha^{-1}
PRK1	Water percolation though first soi layer	mm
LN31	Nitrogen leaching through the first soil layer	kg ha^{-1}
ALB	Soil albedo	
HUI	Heat unit index	
AJHI	Adjusted harvest index based on crop maturity	
LAI	Leaf area index	
BIOM	Total plant biomass (above and below ground)	Mg ha^{-1}
RW	Root weight	Mg ha^{-1}
STL	Above ground biomass	Mg ha^{-1}
HI	Harvest index	
YLDX	Grain yield if harvested on the current day	Mg ha^{-1}
YLDF	Final yield (grain or forage) [2]	Kg ha^{-1}
UNO3	Plant nitrogen uptake in the NO_3 form	kg ha^{-1}
NPP	Net Primary Productivity (daily biomass production × 420)	kg C ha^{-1}
NEE	Net Ecosystem Exchange (RSPC – NPP)	kg C ha^{-1}
LSN	Nitrogen content of structural litter	kg ha^{-1}
LMN	Nitrogen content of metabolic litter	kg ha^{-1}
BMN	Nitrogen content of biomass pool	kg ha^{-1}

Variable name	Description	Unit
HSN	Nitrogen content of slow humus pool	kg ha^{-1}
HPN	Nitrogen content of passive humus pool	kg ha^{-1}
TWN	Total soil organic nitrogen	kg ha^{-1}

[1]PDSW: soil water content above wilting point; FCSW: soil water content between field capacity and wilting point.

[2] If a kill operation occurs on the same day of the harvest operation, the final yield on the harvest day will not be printed.

DWT – Daily Soil Water Content in Control Section and 0.5 m Soil Temp. Output file (ID 18)

The DWT output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Depth of the control sections is reported before the daily output values. Variables included in the DWT file are listed in the following table.

Variable name	Description	Unit
Y#	Year number	
Y	Year	
M	Month	
D	Day	
SW1	Soil water content in control section 1	mm
SW2	Soil water content in control section 2	mm
PAW10	Plant available water at 10 cm depth	m/m
PAW20	Plant available water at 20 cm depth	m/m
PAW50	Plant available water at 50 cm depth	m/m
PAW100	Plant available water at 100 cm depth	m/m
T10	Soil temperature at 10 cm depth	°C
T20	Soil temperature at 20 cm depth	°C
T50	Soil temperature at 50 cm depth	°C

Variable name	Description	Unit
T100	Soil temperature at 100 cm depth	°C
SW10	Soil water content in top 10 cm depth	%

ACY – Annual Crop Yield Output file (ID 19)

The ACY output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Variables included in the ACY file are listed in the following table.

Variable name	Description	Unit
YR	Year	
RT#	Year of simulation	
CPNM	Plant name	
YLDG	Yield grain	Mg ha^{-1}
YLDF	Yield forage	Mg ha^{-1}
WCYD	Moisture content of yield	Fraction
HI	Harvest index	
BIOM	Total plant biomass	Mg ha^{-1}
RW	Root weight	Mg ha^{-1}
YLN	Nitrogen removed with yield	kg ha^{-1}
YLP	Phosphorus removed with yield	kg ha^{-1}
YLC	Carbon removed with yield	kg ha^{-1}
FTN	Nitrogen applied with fertilization (mineral + organic)	kg ha^{-1}
FTP	Phosphorus applied with fertilization (mineral + organic)	kg ha^{-1}
FTK	Potassium applied with fertilization (mineral)	kg ha^{-1}
IRGA	Irrigation water applied	Mm
IRDL	Irrigation distribution losses	Mm
WUEF	Water use efficiency (yield gran and forage / growing season ET)	kg mm^{-1}
GSET	Growing season evapotranspiration	Mm

Variable name	Description	Unit
CAW	Crop available water (soil water content at planting + growing season rainfall – runoff)	Mm
CRF	Growing season rainfall	Mm
CQV	Growing season runoff	Mm
COST	Total cost of production	$ ha^{-1}
COOP	Operation cost	$ ha^{-1}
RYLG	Return for grain yield	$ ha^{-1}
RYLF	Return for forage yield	$ ha^{-1}
PSTF	Pest damage factor (fraction of yield remaining after pest damage)	
WS	Water stress	Days
NS	Nitrogen stress	Days
PS	Phosphorus stress	Days
KS	Potassium stress	Days
TS	Temperature stress (low and high temperature)	Days
AS	Aeration stress (waterlogged soil)	Days
SS	Salt stress	Days
PPOP	Plant population	plants m^{-2}
IPLD	Date when planting operation occurs	YYYYMMDD
IGMD	Date when germination occurs	YYYYMMDD
IHVD	Date when harvest operation occurs	YYYYMMDD

ACO – Annual Cost Output file (ID 20)

The ACO output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Output variables are printed for each operation included in the management used in the simulation. Variables included in the ACY file are listed in the following table.

Variable name	Description	Unit
Y	Year	
M	Month	
D	Day	
OP	Name of operation	
CROP	Plant ID number for the plant receiving the operation	
MT#	Fertilizer of pesticide ID number	
HC	Operation code (IHC from TILLCOM.DAT)	
EQ	Equipment ID number	
TR	Tractor ID number	
COTL	Cost of tillage operation	$ ha^{-1}
COOP	Operation cost	$ ha^{-1}
MTCO	Cost of fertilizer of pesticide operation	$ ha^{-1}
MASS	Mass of fertilizer or pesticide applied	kg ha^{-1}
FUEL	Fuel consumption for operation	L ha^{-1}

DSL – Daily Soil Output file (ID 21)

The DSL output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. The soil table reports values estimated for the end of the day. Variables included in the DSL file are listed in the following table.

Variable name	Description	Unit
DEPTH	Depth to the bottom of the soil layer	M
POROSITY	Porosity of the soil layer	m/m
FC SW	Water content at field capacity	m/m

Variable name	Description	Unit
WP SW	Water content at wilting point	m/m
SW	Water content	m/m
SAT COND	Saturated conductivity	mm h^{-1}
H SC	Lateral hydraulic saturated conductivity	mm h^{-1}
BD 33kpa	Bulk density at field capacity	Mg ha^{-1}
BD DRY	Bulk density when dry	Mg ha^{-1}
SAND	Sand content	%
SILT	Silt content	%
CLAY	Clay content	%
ROCK	Coarse fragment fraction	%
PH	pH	K
SM BS	Sum of bases	cmol kg^{-1}
CEC	Cation Exchange Capacity	cmol kg^{-1}
AL SAT	Aluminum saturation	%
CACO3	Calcium carbonate content	%
LAB P	Labile phosphorus content	g Mg^{-1}
P SORP RTO	Phosphorus sorption ratio	
MN P AC	Active mineral phosphorus content	g Mg^{-1}
MN P ST	Stable mineral phosphorus content	g Mg^{-1}
ORG P	Organic phosphorus content	g Mg^{-1}
NO3	NO_3-N content	g Mg^{-1}
SOLK	Soluble potassium	g Mg^{-1}
EXCK	Exchangeable potassium	g Mg^{-1}
FIXK	Fixed potassium	g Mg^{-1}
ORG N	Organic nitrogen	g Mg^{-1}
ORG C	Organic carbon	%
CROP RSD	Crop residue	Mg ha^{-1}

Variable name	Description	Unit
WLS	Structural litter	kg ha^{-1}
WLM	Metabolic litter	kg ha^{-1}
WLSL	Lignin content of structural litter	kg ha^{-1}
WLSC	Carbon content of structural litter	kg ha^{-1}
WLMC	Carbon content of metabolic litter	kg ha^{-1}
WLSLC	Carbon content of lignin of structural litter	kg ha^{-1}
WLSLNC	Nitrogen content of lignin of structural litter	kg ha^{-1}
WBMC	Carbon content of biomass organic pool	kg ha^{-1}
WHSC	Carbon content of slow humus pool	kg ha^{-1}
WHPC	Carbon content of passive humus pool	kg ha^{-1}
WOC	Organic carbon	kg ha^{-1}
WLSN	Nitrogen content of structural litter	kg ha^{-1}
WLMN	Nitrogen content of metabolic litter	kg ha^{-1}
WBMN	Nitrogen content of biomass pool	kg ha^{-1}
WHSN	Nitrogen content of slow humus pool	kg ha^{-1}
WHPN	Nitrogen content of passive humus pool	kg ha^{-1}
WON	Organic nitrogen	kg ha^{-1}
ECND	Electrical conductivity	mmho cm^{-1}
WSLT	Salt content	kg ha^{-1}
STFR	Fraction of water storage interacting with nitrogen leaching	
CGO2	Soil O2 emission [1]	kg ha^{-1}
CGCO2	Soil CO2 emission[1]	kg ha^{-1}
CGN2O	soil N2O emission[1]	kg ha^{-1}

[1] Variables available only if the Izaurralde denitrification approach (IDN = 3 or IDN = 4) is selected by the user.

MWC – Monthly Water and Nitrogen Cycle Output File (ID 22)

The MWC output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Multiple rows for the same date are printed if more than one plant is simulated. Variables included in the MWC file are listed in the following table.

Variable name	Description	Unit
Y	Year	
M	Month	
PRCP	Precipitation	Mm
PET	Potential evapotranspiration	Mm
ET	Evapotranspiration	Mm
EP	Plant transpiration	Mm
Q	Surface runoff	Mm
SSF	Lateral subsurface flow	Mm
PRK	Percolation below the root zone (added to the ground water storage)	Mm
QDRN	Water flow from a drainage system	Mm
IRGA	Irrigation water applied	Mm
QIN	Inflow to the root zone from the water table	Mm
RZSW	Soil water in soil profile explored by root	Mm
WTBL	Depth to water table	M
GWST	Groundwater storage	Mm
RNO3	Nitrogen added from precipitation	kg ha^{-1}
YON	Nitrogen loss with sediment	kg ha^{-1}
QNO3	Nitrogen loss with surface runoff	kg ha^{-1}
SNO3	Nitrogen loss with subsurface lateral flow	kg ha^{-1}
VNO3	Nitrogen loss with percolation	kg ha^{-1}
DN	Denitrification	kg ha^{-1}
DN2	Loss of dinitrogen gas [1]	kg ha^{-1}
AVOL	Nitrogen volatilization	kg ha^{-1}

Variable name	Description	Unit
HMN	Nitrogen mineralized from stable organic matter	kg ha^{-1}
NFIX	Nitrogen fixation from legumes	kg ha^{-1}
FNO	Organic nitrogen fertilizer applied	kg ha^{-1}
FNO3	Nitrate nitrogen fertilizer applied	kg ha^{-1}
FNH3	Ammonium nitrogen fertilizer applied	kg ha^{-1}
UNO3	Plant nitrogen uptake	kg ha^{-1}
YLN	Nitrogen removed with yield	kg ha^{-1}
CPNM	Crop name	
YLD	Yield	Mg ha^{-1}
TOTN	Total nitrogen (soil (organic and mineral) + standing dead + plant)	kg ha^{-1}

[1] DN2 available only with Izaurralde denitrification approach (IDN = 3 or IDN = 4)

ABR – Annual Biomass Root Weight Output File (ID 23)

The ABR output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Multiple rows for the same date are printed if more than one plant is simulated. Variables included in the ABR file are listed in the following table.

Variable name	Description	Unit
Y	Year	
Y#	Year number	
M	Month of the day when RW start reducing	
D	Day when RW start reducing	
CROP	Crop name	
BIOM	Total plant biomass	Mg ha^{-1}
RWT SOIL LAYER #	Root weight (values are reported for each soil layer – columns)	Mg ha^{-1}
DEPTH	Depth to the bottom of the soil layer	m

ATG – Annual Tree Growth Output File (ID 24)

The ATG output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. This file is printed only if at least one tree is included in the simulation. If more than one tree is simulated, one row will be printed for each tree included in the simulation. Variables included in the ATG file are listed in the following table.

Variable name	Description	Unit
`Y`	Year	
`Y#`	Year number	
`CROP`	Plant name	
`YLD`	Yield[1]	Mg ha^{-1}
`BIOM`	Total plant biomass	Mg ha^{-1}
`RWT`	Root weight	Mg ha^{-1}
`LAI`	Leaf Area Index	
`STD`	Standing dead plant residue	

[1] The yield reported here is the one obtained considering the override harvest index (see ORHI for more information).

MSW – Monthly Output File to SWAT (ID 25)

The MSW output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. This is a special file used to pass information to the Soil Water Assessment Tool (SWAT) model. Variables included in the MSW file are listed in the following table.

Variable name	Description	Unit
`Column 1`	Year number	
`Column 2`	Month	
`Column 3`	Sum of Q + SSF + QDRN	mm
`Column 4`	Water-driven soil erosion estimated with approach selected by the user (DRV in EPIC control file).	Mg ha^{-1}
`Column 5`	Nitrogen loss with sediment	kg ha^{-1}
`Column 6`	Phosphorus loss with sediment	kg ha^{-1}

Variable name	Description	Unit
Column 7	Sum of QNO3 + SNO3 + DRNN	kg ha^{-1}
Column 8	Phosphorus (labile) loss with surface runoff	kg ha^{-1}
Column 9	NA	
Column 10	NA	
Column 11	NA	
Column 12	NA	
Column 13	NA	
Column 14	NA	
Column 15	NA	
Column 16	NA	
Column 17	NA	
Column 18	Variation of total nitrogen in litter and organic pools	kg ha^{-1}

APS – Annual Pesticide Output File (ID 26)

The APS output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Variables included in the APS file are listed in the following table. Values are printed only if at least one pesticide application is simulated.

Variable name	Description	Unit
YR	Year	
YR#	Year number	
Q	Surface runoff	mm
SSF	Lateral subsurface flow	mm
PRK	Percolation below the root zone (added to the ground water storage)	mm
QDRN	Water flow from a drainage system	mm
Y	Water-driven soil erosion	Mg ha^{-1}
YOC	Carbon in sediment	kg ha^{-1}
One row for each pesticide included in the simulation is printed for the following variables		

Variable name	Description	Unit
PSTN	Pesticide name	
CPNM	Crop name	
PAPL	Amount of pesticide applied	g ha^{-1}
PSRO	Pesticide in surface runoff	g ha^{-1}
PLCH	Pesticide in percolating water	g ha^{-1}
PSSF	Pesticide in lateral subsurface flow	g ha^{-1}
PSED	Pesticide transported by sediment	g ha^{-1}
PDGF	Pesticide degradation from foliage	g ha^{-1}
PDGS	Pesticide degradation from soil	g ha^{-1}
PDRN	Pesticide in drainage system outflow	g ha^{-1}
CMX4D	Pesticide 4-day runoff	ppb

DWC – Daily Water Cycle Output File (ID 27)

The DWC output file is printed with a variable format and the user can select the variables to print and their position in the output file. Variables are selected by editing the EPIC print file (PRNT1102.DAT) at rows 9 and 10 (Daily output variables) for the first part of the DWC output file and rows 7 and 8 (State variables) for the second part of the DWC file. First the model will print all the variables selected on line 9 and 10 and then all the variables selected on line 7 and 8. For instance, if only the precipitation (ID 4) is selected on line 9 and 10 and TNH3 (ID 1) and TNO3 (ID 2) are selected on line 7 and 8, the DWC file will be printed with PRCP, TNH3, and TNO3. See the general part on the EPIC print file for more information on the variable available and their IDs.

DHS – Daily Hydrology/Soil Output File (ID 28)

The DHS output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Variables included in the DHS file are listed in the following table.

Variable name	Description	Unit
Y	Year	
M	Month	
D	Day	
SW15	Soil water content in the 0-15 cm depth	m/m
SW30	Soil water content in the 0-30 cm depth	m/m
NO315	Soil NO_3-N content in the 0-15 cm depth	g N/Mg
NO330	Soil NO_3-N content in the 0-30 cm depth	g N/Mg
NH315	Soil NH_3-N content in the 0-15 cm depth	g N/Mg
NH330	Soil NH_3-N content in the 0-30 cm depth	g N/Mg
PRCP	Precipitation	mm
PET	Potential evapotranspiration	mm
ET	Evapotranspiration	mm
EP	Plant transpiration	mm
Q	Surface runoff	mm
CN	NRCS Curve number	mm
SSF	Lateral subsurface flow	mm
PRK	Percolation below the root zone (added to the ground water storage)	mm
QDRN	Water flow from a drainage system	mm
IRGA	Irrigation water applied	mm
QIN	Inflow to the root zone from the water table	mm
RZSW	Soil water in soil profile explored by root	mm
WTBL	Depth to water table	m
GWST	Groundwater storage	mm
Z1 - Z10	Depth to bottom of soil layer from 1 to 10	m

Variable name	Description	Unit
`SW1 - SW10`	Soil water content in soil layer 1 to 10	mm
`WU1 - WU10`	Plant water uptake from soil layer 1 to 10	mm
`EV1 - EV10`	Evapotranspiration from layer 1 to 10	mm
`PK1 - PK10`	Percolation trough layer 1 to 10	mm
`SF1 - SF10`	Later subsurface flow for layer 1 to 10	mm
`N31 - N310`	NO_3-N content in layer from 1 to 10	kg ha^{-1}
`UN1 - UN10`	Plant nitrogen uptake from layer 1 to 10	kg ha^{-1}
`LN1 - LN10`	Nitrogen in water percolating trough layer 1 to 10	kg ha^{-1}

DGZ – Daily Grazing Output File (ID 29)

The DGZ output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Variables included in the DGZ file are listed in the following table. Values are printed only if grazing is simulated.

Variable name	Description	Unit
`Y`	Year	
`M`	Month	
`D`	Day	
`OPERATION`	Operation name	
`CROP`	Crop name	
`BIOM`	Total plant biomass (above and below ground)	Mg ha^{-1}
`RWT`	Root weight	Mg ha^{-1}
`LAI`	Leaf Area Index	
`STL`	Standing live biomass (aboveground)	Mg ha^{-1}
`AGPM`	Aboveground plant biomass (live + dead)	Mg ha^{-1}
`ORHI`	Override harvest index (corrected considering AGPM)	
`YLD`	Yield (plant biomass (STL + STD) grazed)	Mg ha^{-1}
`YLDS`	STD yield (STD biomass grazed)	Mg ha^{-1}
`HUSC`	Ratio between accumulated heat units and PHU [1]	

[1] To simulate the capability of plants to produce new leaves and stems when grazed (or cut), the accumulated heat units are reduced by the grazing activity.

DNC – Daily Nitrogen/Carbon from Cesar Izaurralde Approach Output File (ID 30)

The DGZ output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Variables included in the DNC file are listed in the following table. Values are printed only if one of the Izaurralde approaches for denitrification is selected by the user (IDN = 3 or IDN = 4 in EPIC control file (EPICCONT.DAT)).

Variable name	Description	Unit
Y	Year	
M	Month	
D	Day	
PRCP	Precipitation	mm
VWC1 – VWC10	Soil water content in computational soil layer 1 to 10 [1]	m/m
AFP1 – AFP10	Soil occupied by air in computational soil layer 1 to 10 [1]	m/m
WNH31 – WNH310	NH_3-N in soil computational layer 1 to 10 [1]	kg ha^{-1}
WNO31 – WNO310	NO_3-N in soil computational layer 1 to 10 [1]	kg ha^{-1}
WNO21 – WNO210	NO_2-N in soil computational layer 1 to 10 [1]	kg ha^{-1}
WO2L1 – WO2L10	Oxygen concentration in liquid phase of soil computational layer 1 to 10 [1]	kg ha^{-1}
WO2G1 – WO2G10	Oxygen concentration in gas phase of soil computational layer 1 to 10 [1]	kg ha^{-1}
DO2CONS1 – DO2CONS10	Oxygen consumption in soil computational layer 1 to 10 [1]	kg ha^{-1}
DFO2S	Surface flux of O_2	kg ha^{-1}
DBFO2B	Change in soil O_2 content	kg ha^{-1}
DFO2T	Total flux of O_2	kg ha^{-1}
QO2	O2 in surface runoff	kg ha^{-1}
SSFO21 – SSFO210	Oxygen in lateral subsurface flow in computational soil layer 1 to 10 [1]	kg ha^{-1}
VO21 – VO210	Oxygen in water percolating trough soil computational layer 1 to 10 [1]	kg ha^{-1}
WCO2L1 – WCO2L10	CO_2 concentration in liquid phase of soil computational layer 1 to 10 [1]	kg ha^{-1}

Variable name	Description	Unit
`WCO2G1 – WCO2G10`	CO_2 concentration in gas phase of soil computational layer 1 to 10 [1]	kg ha^{-1}
`DCO2GEN1 – DCO2GEN10`	CO2 generated in soil computational layer 1 to 10 [1]	kg ha^{-1}
`DFCO2S`	Surface flux of CO_2	kg ha^{-1}
`DFCO2B`	Change in soil CO_2 content	kg ha^{-1}
`DFCO2T`	Total CO_2 flux	kg ha^{-1}
`QCO2`	CO_2 in surface runoff	kg ha^{-1}
`SSFCO21 – SSFCO210`	CO_2 in lateral subsurface flow in computational soil layer 1 to 10 [1]	kg ha^{-1}
`VCO21 – VCO210`	CO_2 in water percolating trough soil computational layer 1 to 10 [1]	kg ha^{-1}
`WN2OL1 – WN2OL10`	N_2O-N in liquid phase of soil computational layer 1 to 10 [1]	kg ha^{-1}
`WN2OG1 – WN2OG10`	N_2O-N in gas phase of soil computational layer 1 to 10 [1]	kg ha^{-1}
`DFN2OS`	Surface flux of N_2O	kg ha^{-1}
`DFN2OB`	Change in soil N_2O content	kg ha^{-1}
`DFN2OT`	Total flux of N_2O	kg ha^{-1}
`QN2O`	N_2O in surface runoff	kg ha^{-1}
`SSFN2O1 – SSFN2O10`	N_2O in lateral subsurface flow in computational soil layer 1 to 10 [1]	kg ha^{-1}
`VN2O1 – VN2O10`	N_2O in water percolating trough soil computational layer 1 to 10 [1]	kg ha^{-1}
`DN2OG1 – DN2OG10`	N_2O-N gas generated in soil computational layer 1 to 10 [1]	kg ha^{-1}
`DN2G1 – DN2G10`	N_2 gas generated in soil computational layer 1 to 10 [1]	kg ha^{-1}

ASL – Annual Soil Table Output File (ID 31)

The ASL output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. Variables included in the ASL file are the same as the Daily Soil Output file (DSL, ID 21).

Variable name	Description	Unit
Y	Year	
M	Month	
D	Day	

DDN – Daily Denitrification Output File (ID 32)

The DDN output file is printed with a fixed format (variable type and position) and the user cannot select the variables printed in it. The DDN output file includes data for 10 soil layers. The header has the original number of the soil layer before splitting operation occurs. Therefore, layers deriving from the same original layer have the same layer ID number. Variables included in the DDN file are listed in the following table. This output file works with the Kemanian denitrification approach (IDN = 2).

Variable name	Description	Unit
Depth	Depth to the bottom of the soil layer	m
SW	Soil water content	m/m
TEMP	Soil temperature	°C
RSD	Crop residue	Mg ha^{-1}
BIOMIX	Biological mixing (meters of soil mixed by biological activity)[1]	m
CO2 LOSS	CO_2 losses	kg C ha^{-1}
NET MN	Net mineralization	kg N ha^{-1}
WNO3	NO_3-N in soil layer	kg ha^{-1}
WNO3F	Nitrate factor used in the Kemanian denitrification approach	
CBNF	Respiration factor used in the Kemanian approach	
DN	Denitrification	kg ha^{-1}

OUTPUT ANALYSIS

Failed runs

A simulation with the EPIC model can fail for several reasons. Some checks can be performed by the user prior to asking for technical support. The most common reason of a failed run is a missing input file or a missing data required by the model. Specific examples are:

1. Soil data (*filename*.SOL)
    a. Missing essential data.
    b. Layer depth out of order.
    c. Curve number input instead of hydrologic soil group number on line two.
2. Operation schedule (*filename*.OPC or *filename*.OPS)
    a. Land use number not input on line two.
    b. Format problem (e.g., data input in wrong columns).
    c. Dates not in sequence.
3. When daily weather is input
    a. Incorrect format.

In the case a required input file is missing, the model prints an error message visible in the command prompt windows that appears when the model is running. Because the execution time is very fast, this window disappears quickly. To be able to see the error message, it is possible to run the model from the command prompt windows instead of double-clicking on the executable. To do so, open the command prompt from Windows, move to the directory where the executable and the EPIC input files are located, and launch the program by typing the name of the executable and hitting Enter.

Examples of problems that may or may not cause a failed run are:

1. Soil data
    a. Inconsistent data.
    b. Bulk density/texture data.
    c. Texture/plant available water.
    d. Organic C/N/P content.
2. Operation schedule
    a. No kill operation to terminate the growth of an annual crop.

Problems that cause a near zero crop yield:

1. Atmospheric CO2 concentration set to zero.
2. Different units used for monthly and daily solar radiation when daily weather data is used.

General problems

1. Working files do not match those contained in APEXFILE.DAT. For example, the APEXFILES.DAT contains the name USERCROP.DAT for the EPIC plant list, but the name of the EPIC plant list is EPICCROP.DAT in the working directory. See the section about the APEXFILE.DAT for more information.
2. When daily weather data is used, the date must be input on the first line as year, month, day following the format described in the section EPIC daily weather file. The beginning simulation date in EPICCONT.DAT must be equal or greater than the one appearing on the first line of the daily weather file used in the simulation. If not, daily weather data for the entire simulation will be generated.

General output analysis

The simulation was completed if a time stamp is present at the very end of the OUT-output file. Always check for this when you are running a new simulation for the first time.

Check nutrient and water balances for each run (look for BALANCE). As reported before in the OUT section, the variables PER and DF should be near zero.

Check average annual surface runoff, water yield, and sediment and nutrient. If the previous analysis shows problems in the simulation of the runoff, the following steps should be taken by the user.

1. Check simulated PET for not reasonable values. If the simulated PET is not realistic for the simulated area, try another PET equation that may be more appropriate for the site. Hargreaves is the most robust and can be adjusted by varying the coefficient (PARM(38) 0.0023-0.0032) or the exponential (PARM(13) 0.5-0.6) in the EPIC parameters file (PARM1102.DAT). Penman-Monteith is generally considered the most accurate but is sensitive to wind speed which is subject to measurement errors. It can also be adjusted through the stomatal conductance coefficient (PARM(1) 1.0-2.0) and the adjustment factor (PARM(74) 0.5-1.5) in PARM1102.DAT. The Baier-Robertson equation developed in Canada is a good choice in cold climates.
2. Check the simulated ET for not reasonable values. If the simulated ET is not realistic for the simulated area the crop growing season may be incorrect. Check planting and harvest dates and potential heat units in the EPIC management file. Also, you can use the OUT output file with daily output printed to check the harvest time in each year. In the section where the operations performed during the simulation are reported, check the value of HUSC at the harvest operation. Normally, grain crops should be harvested with HUSC value between 1.0 and 1.2. If HUSC at harvest is < 1.0, the PHU value input in the management file for that plant is too large or harvest date is too early. If HUSC is > 1.2 PHU is too small or harvest date is too

late. In case of perennial plants that are grazed or harvested for hay, these may be grazed too closely or cut too often to allow leaf area to develop properly for normal plant water use.

3. Check the runoff equation used in the simulation. When using the NRCS curve number(CN) equation, the CN equation varies with soil water. EPIC has four different methods of linking CN and soil water plus a constant CN option. The methods available are:
   - 0 Variable daily CN nonlinear CN/SW with depth soil water weighting.
   - 1 Variable daily CN nonlinear CN/SW without depth weighting.
   - 2 Variable daily CN linear CN/SW no depth weighting.
   - 3 Non-Varying CN--CN2 used for all storms.
   - 4 Variable Daily CN SMI (Soil Moisture Index).

   Generally, the soil moisture index (5) is the most robust and reliable because it is not sensitive to errors in soil data. This method is adjustable using PARM(42) in PARM1102.DAT. PARM(42) usually is in the range 0.3-2.5 (small values reduce runoff). The nonlinear forms (option 0 and 1) also perform very well in many situations. The constant CN method (3) is a good choice when soil water is not a dominant factor.

   The Green and Ampt (G&A) infiltration equation can be used in special cases where CN is not performing well. The three variations of G&A are:
   1. Rainfall intensity is simulated with a double exponential distribution and peak rainfall rate is simulated independently.
   2. Same as (1) except peak rainfall rate is input.
   3. Rainfall intensity is uniformly distributed, and peak rainfall rate is input (useful in rainfall simulator studies).
4. Check for erosion/sedimentation problems.
   a. Runoff must be realistic.
   b. Crop growth must be realistic to provide proper cover and residue.
   c. Tillage must mix residue with soil properly.
   d. Erosion equations: The USLE and five modifications are available. MUSLE, MUSS, and MUST usually give similar results and are appropriate for estimating sediment yield from small watersheds up to about 250 km^2. The USLE is an erosion equation that is useful in studies like assessing the effect of erosion on productivity.
5. Slope length and steepness factor: Both USLE and RUSLE equations are available. RUSLE is preferred for steep slopes > 20%.

Plant growth is another aspect that should be analyzed at the end of a simulation. In the general output file (.OUT) search for “AVE ANNUAL VALUES” and look at the data in the plant section. The stress days reveal the stresses that are constraining crop growth. Root growth stresses of bulk density (BD) or aluminum saturation (ALSAT) can reduce crop yields greatly. If high root stress is reported in the OUT file, go to SOIL DATA and check for unreasonably high BD, and high aluminum saturation (values > 90 caused by low pH <5). During the simulation, BD can be lowered by deep tillage or simply corrected if the data are erroneous. Aluminum saturation can be lowered by applying lime or by correcting erroneous pH data.

Water stress is the most common constraint to crop growth. Excessive PET or runoff estimates are major causes. Plant available water is another important limitation that causes water stress. Erroneous estimates of plant available water occur when field capacity or wilting point are incorrect. Soil water storage is particularly important in dry climates.

Nitrogen and Phosphorus stress is caused by low mineralization rates, inadequate fertilizer, or excessive leaching of N. In the OUT file, go to SOIL DATA and examine organic N, P, and C. C/N should be near 10. N/P should be near 8. The mineralization rate can be increased by decreasing the number of years of cultivation at the beginning of simulation (see variable RTN0 in the EPIC soil file). In section AVERAGE ANNUAL VALUES of the OUT file, check for N losses and inputs. Large losses with percolation may result from low ET or runoff, low soil plant available water storage (FC -WP), or high saturated conductivity values. PRK is sensitive to the user choice to use manual irrigation applications of rigid amounts.

How to check and validate crop yield

USER NOTE OF CAUTION: If a multiple-run has been executed (denoted by a value greater than zero in col. 4 in MLRN0810.DAT) all the output files (including the OUT file) will contain results for all the runs executed with the normal and multiple run option. For instance, if a normal run of 5 years has been executed (NBYR = 5 in EPIC control file) and a simulation of 2 years has been set in the EPIC multirun file, the ACY output file will have results for the first 5 years followed by two more years. In the OUT file, the results of the multirun are reported after the results for the normal run.

- First, check the accuracy of soil depths if specific simulated yields are low. To determine if soil depth and the important related water-holding capacity is curtailing a specific crop yield, open the ACY output file where both grain and forage yields are listed by crop. Data entry errors in the depth of soil data can be checked by opening the appropriate *.SOL file and referring to the accumulated depth (m) of the last soil layer.
- Second, check the accuracy of the heat units from planting to harvest. After completing a run if automatic heat unit scheduling is not selected in EPIC control file (see IHUS in EPICCONT.DAT), open the general output file (OUT) and, as described before, look for the HUSC reported for the harvest operations. This value is reported when the daily simulated operations are printed in the OUT file (see IPD in the EPICCONT.DAT file). If multiple harvest operations of grain crops in different years have HUSC values outside the range of 0.9 to 1.2, check both the planting (above the harvest operations) and the harvest date for accuracy. If they are accurate to the best of your knowledge, then the PHU in the management file might need to be adjusted. If HUSC for grain harvest operation in the OUT file is less than 1.0,

decrease the heat units at the planting operation and if greater than 1.0, increase the heat units.

If automatic heat unit scheduling is selected in EPICCONT.DAT, open the OUT file and follow the same procedure as above except instead of changing the heat units, change either the plant or harvest date to result in a more optimum HUSC = approx. 1.0 for the grain harvest operation.

- Third, check the plant population for accuracy. If a crop yield is too low, check the plant population in the EPIC management file (OPS or OPC) Correct to the best of your knowledge. Increasing (Decreasing) it will increase (lower) the simulated yield. Increasing plant population usually increases yield but not always—sometimes in very dry climates lower populations produce higher yield.
- Fourth, check plant stress levels if a crop yield is low. To determine the cause of stress to biomass and root development from lack of water, nutrients, bulk density, excessive aluminum toxicity, or insufficient air for biomass or roots, open the general output file (OUT) and find AVE ANNUAL VALUES. In the section dedicated to the plants included in the simulation, if the plant of interest is not in the first listing, scroll down to subsequent listings. Look for the STRESS days reported for biomass (BIOM) and roots (ROOT).For example, if a large number of days of N stress are observed, open the management file used in the simulation, check if the amount of nitrogen applied is correct and add more N fertilizer if needed; continue to do the same for the crop(s) with P stress, and if irrigation is being applied manually and water stress days are high, the same can be done for irrigation water. In contrast, if air stress days are high in either roots or biomass, reduce irrigation applications. Aluminum toxicity stress is usually a soil condition treated by adding lime (automatically applied if selected in the EPIC control file with variable LMS). If soil bulk density causes root stress, check the soil file used in the simulation for errors in the bulk density data entries for each subarea that produces the affected crop. Also, check PARM(2)—the original value is 1.15 but may need to increase to 1.5 for many cases to reduce bulk density stress. Setting PARM(2) to 2.0 eliminates all root stresses.
- Fifth, check the leaf area index (MXLA) in the EPIC plant list file. To determine if the leaf area setting is inadequate for optimum yields of a crop, open the OUT file and find CROP PARAMETERS. Scroll down to a row indicating MXLA for the value of a low yielding crop and compare it with the value DMLA reported in the same section of the OUT file. If the two leaf area indices are near equal and the crop yield is low, DMLA in the EPIC plant list file could be adjusted. DMLA is set at the maximum LAI that the crop can obtain under ideal conditions so it seldom needs increasing. MXLA is the adjusted DMLA based on plant population and can be increased by increasing population.
- Sixth, revise the Harvest Index and Biomass-Energy Ratios. If after the first five checks are completed and crop yields remain inaccurate, some basic crop parameters can be revised as a last resort. **Normally these parameters are not to be revised, being accurate for crops in the U.S.** They may need to be revised slightly for international use. In EPICCROP.DAT, the harvest

index (HI) relates to the grain yield only as a ratio of the above-ground biomass. The higher the ratio, the more grain yield reported for a given level of biomass. Similarly, the biomass to energy ratio (WA) increases yields through biomass changes and, therefore, both grain and forage yields increase.

How to check and validate runoff and sediment losses.

USER NOTE OF CAUTION: If a multiple-run has been executed (denoted by a value greater than zero in col. 4 in MLRN0810.DAT) all the output files (including the OUT file) will contain results for all the runs executed with the normal and multiple run option. For instance, if a normal run of 5 years has been executed (NBYR = 5 in EPIC control file) and a simulation of 2 years has been set in the EPIC multirun file, the ACY output file will have results for the first 5 years followed by two more years. In the OUT file, the results of the multirun are reported after the results for the normal run.

TO CHECK THE ACCURACY OF SIMULATED RUNOFF/SEDIMENT LOSSES AND SEDIMENT LOSSES FOR THE WATERSHED OUTLET, open the ANN file for the yearly simulated losses and consult your EPIC0810 manual for the definitions of the column headings. If QTW values for the years being validated are unacceptable, usually YW will also be in error, follow the instructions below:

1. Check land use values. Correct runoff/sediment losses by checking the accuracy of estimated curve numbers that dictate runoff/sediment losses. This may be done by checking the land use number in line 2 (LUN) of the management file used in the simulation. If multiple crop rotations are used, simulated runoff/sediment losses accuracy will be enhanced if LUN is revised at planting and harvest of each crop by entering a value on the appropriate operation line.
2. Check hydrologic soil group values. Correct runoff/sediment losses by checking the accuracy of the hydrologic soil group in line 2 (HSG) in the soil file used in the simulation.
3. Check upland and channel hydrology values. Correct runoff/sediment losses by checking the hydrology of the field. Open the *.OUT file and find relevant information in the "General information" section (e.g. channel and slope data). This information helps in understanding if the field hydrology is correctly replicated in the model.
4. Check monthly and annual rainfall values. Correct runoff/sediment losses by checking the simulated monthly and annual rainfall for the simulated years.
5. Check the saturated conductivity values for soils. Correct runoff/sediment losses by checking the accuracy of the saturated conductivity values of the soil used in the simulation.
6. Check the accuracy of the erosion control practice factor. Correct runoff/sediment losses by checking the accuracy of the erosion control practice factor (see PEC0 in EPIC control file and PEC in EPIC site file).

7. Check the choice of water 0erosion equation. For watershed analyses, sediment losses need to be indicated with the recommended choices of #3 (MUSS) or #0 (MUST) for variable DRV in the EPIC control file.
8. Revise the method of calculating the daily adjusted curve numbers. See ISCN and NVCN in the EPIC control file and revise the method of calculating daily adjusted curve numbers.
9. Revise the irrigation runoff ratios if irrigation operations are used. Revise the global irrigation runoff ratio using EFI in the EPICCONT.DAT file or OPV4 in the management file for individual irrigation applications.

If the error is observed for runoff (Q) and/or water flow from drainage system (QDRN), follow the next steps:

1. Check land use (curve number) values. Correct runoff/sediment losses by checking the accuracy of estimated curve numbers that dictate runoff/sediment losses. This may be done by checking the land use number (LUN) in the management file used in the simulation. If multiple crop rotations are used, simulated runoff/sediment losses accuracy will be enhanced if LUN is revised at planting and harvest of each crop by entering a value on the appropriate operation line (see section on the EPIC management file for more information). NOTE: Land use numbers may be substituted with curve numbers.
2. Check the saturated conductivity values for soils. Correct runoff/sediment losses by checking the accuracy of the saturated conductivity values of the soil used in the simulation.
3. Check hydrologic soil group values. Correct runoff/sediment losses by checking the accuracy of the hydrologic soil group (HSG) on line two of the soil file used in the simulation. This value should be consistent with the % sand, % silt, and the residual % clay.
4. Check monthly and annual rainfall values. Correct runoff/sediment losses by checking the simulated monthly and annual rainfall for the simulated years.
5. Check the accuracy of the erosion control practice factor. Correct runoff/sediment losses by checking the accuracy of the erosion control practice factor (see PEC0 in EPIC control file and PEC in EPIC site file).
6. Check the choice of water erosion equation. For watershed analyses, sediment losses need to be indicated with the recommended choices of #3 (MUSS) or #0 (MUST) for variable DRV in the EPIC control file.
7. Revise the method of calculating the daily adjusted curve numbers. See ISCN and NVCN in the EPIC control file and revise the method of calculating daily adjusted curve numbers.
8. Revise the irrigation runoff ratios if irrigation operations are used. Revise the global irrigation runoff ratio using EFI in the EPICCONT.DAT file or OPV4 in the management file for individual irrigation applications.

If errors in the simulation of SSF are observed, it might be required to adjust the later hydraulic conductivity (HCL) in the soil file used in the simulation.

Only after checking and correcting errors in the simulation of runoff, is it possible to check and calibrate the simulation of soil and nutrient losses that are driven by water dynamic.

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