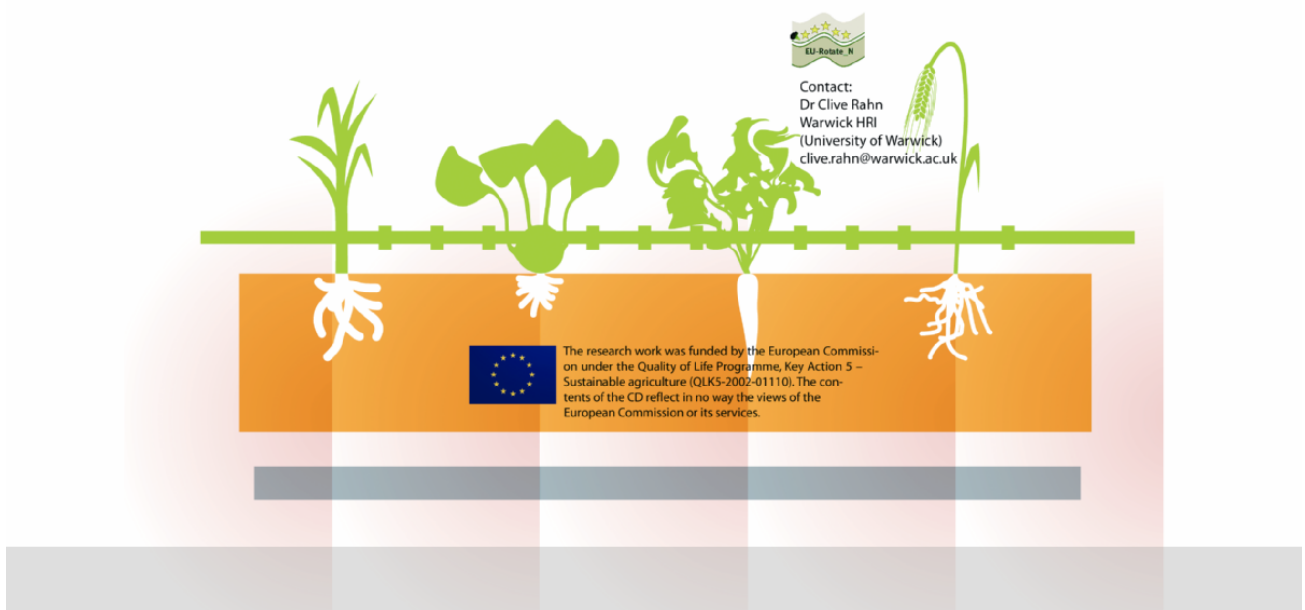# USER MANUAL EU-ROTATE_N

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EU-Rotate_N is a four year project, funded by the European Commission within the Fifth Framework Programme, and is co-ordinated by Dr Clive Rahn at Warwick HRI. Partner organizations include HDRA UK, IGZ and BOLAP Germany, IVIA and CSIC Spain, Bioforsk Norway, DJF Denmark and ISOR Italy.

The developers can be contacted at eurotaten@warwick.ac.uk or visit the website at www.warwick.ac.uk/go/eurotaten

1. MODEL OVERVIEW INTERNET AND PC VERSIONS

A new model has been written and tested which enables the economic and environmental performance of crop rotations in either conventional or organic cropping for a wide range of crops and growing conditions in Europe. The model, though originally based on the N_ABLE model, has been completely rewritten and contains new routines to simulate root development, the mineralisation and release of N from soil organic matter and crop residues, the effect of freezing, and water movement. New routines have also been added to estimate the effects of sub-optimal rates of N and spacing on the marketable outputs and gross margins. Model performance was tested against experimental results and broadly simulated the patterns of growth N response and N losses. The model provides a mechanism for comparing the relative effects of differing cropping and fertilisation practices on yield gross margin and losses of nitrogen through leaching. The running of a number of scenarios has demonstrated that nitrogen management can be improved in Europe by following at least Good Agricultural Practice but does provide the potential for suggesting improvements which have a minimal effect on gross margin whilst reducing nitrogen losses.

VERSIONS

There are now 2 versions of the model – one PC based as before and the other a   new web based version of the model . Both versions can be accessed from
www.warwick.ac.uk/go/eurotaten

The web based version allows easier creation of the input files. More details are provided in **section 8**

The PC based version is described in **section 2**

Note There are slight differences in the format of the input files for the PC and web based versions which are explained in **section 8.2**

2. GETTING STARTED PC VERSION

2.1 Computer Specifications
Currently the model has been successfully run on any modern computer with Windows 98, Windows 2000 or Windows XP. The computer does need to be equipped with at least 512MB of RAM. Optimal performance is given if 1GB is available. There must be enough hard disk space on the computer to hold the output files. In normal *brief* mode this is nominal but in the *detailed* mode some of the output files can be several GB in size.

2.2 Setting up and first runs of the model
The model can be downloaded from EU-ROTATE_N web site as a single ZIP file which

contains:

- Folder labelled **Model** containing the program files including
    - an executable file *EU-ROTATE_N_1-8.exe*;
    - a crop parameter file *CropTable1-8.txt*;
    - a crop residue parameter file *ResidueTable1-8.txt*;
    - an organic fertiliser parameter file *OrganicFertilisers1-8.txt*;
    - an inorganic fertiliser parameter file *MineralFertilisers1-8.txt*,
    - a utility *Readfile(rev).xls* to read output files
    - a dynamically linked library *salflibc.dll* from Salford software
    - an example input file ready to run *test.dia*
    - weather data file for the input file *Weather.met*
- Folder labelled **Examples** including
    - Four example files ready to run
    - Weather data associated with examples – *weather.met*
- A folder labelled **Manuals** including
    - This user Manual
    - Model Description in *Model description.pdf*
    - Example files in word format
    - A list of known issues that need to be taken account of when running the model in *Known Issues.pdf*
    - A list of major modifications made since the original 1.6 version of the model are listed in *Updating.pdf*
- A folder labelled **Publications** including
    - Copies of Project newsletters
    - Copy of Conference paper with an example of how the model can be used.
- A Folder labelled **Read Me** containing the
    - Access rights agreement
    - Description of disc in MS notepad format.

To run the model all the files in the **Examples** and **Model** directories need to be placed in the **same directory**. Set up an area on your computer where you want the model files to run.

There are two ways of running the model.

In WINDOWS: double click *EU-ROTATE_N_1-8.exe*, a blank screen appears and type on it the name of the input file, i.e. T*est.dia* followed by return. The screen disappears and the output files appear in the same directory.

In MS-DOS: type *EU-ROTATE_N_1-8* followed by return, on the next line type the name of the input file, i.e. T*est.dia* followed by return. Output files appear in the same directory.

For the simple example file, *Test.dia* the model should take only a short time but it may

take several minutes for crops containing long rotations of crops.

2.3 Example Input files

Four files are included with the model, see appendix 3 and 4. The simplest of the four files is called *test1.dia* and contains the minimum of information to run the model. It includes a single soil layer, a single crop with no irrigation or fertilization. The model will not run with less data than supplied here. The second file *test2.dia* is more complex and includes a simple fertilization and irrigation trigger. Three soil layers have been initialized. The third file, *test3.dia* contains a rotation of two crops but again with only one single fertilisation and irrigation per crop. A fourth example, *complex.dia* is more complex and includes all the main model triggers in situ for a one season crop. It will run but will take longer to run that the other three.

These files can be used as a basis of making other files to represent other rotations. To start with it is better to edit existing files and the process is described below in 2.4.

The files are available in two forms *.dia and *.doc. The doc files are for reference purposes only. The dia files are the only files that the model will read.

2.4 To read and edit existing files

The input files can be read in any text reader, even WORD, but it is important that any revised files are in a format that can be read by the model. It is recommended that the existing files are edited in the DOS editor or using NOTEPAD. **The files can also be created and edited in the web based version of the model see section 8**.

In the file you will see a set of characters down the left hand side and descriptions for each line in the centre of the page. The character strings on the left can be edited by the user to change, for example, the date of planting, harvesting etc. These are described in more detail in section 3 of this user guide. Some questions if answered yes require additional data to be inserted – see section 3. The text in the centre describing the input must remain separated from the input data by spaces or tabs or it will interfere with the data.

There are certain headings which should not be edited and these are shown below.

1. Site properties
2. Simulation period
3. Weather file
4. Switch for winter climate simulation
5. Soil properties
6. Initial conditions
7. Soil mineral N updates
8. Previous crop residue incorporation
9. Number of crops in rotation (from fertilisation to residues incorporation)
10. Fertilisation

11. Irrigation
12. Crop data
13. Crop residues

For **multiple crops in rotations** sections 10-13 are repeated, each crop having its own fertilizer, irrigation, crop data and residue incorporation. The number of crops in the rotation is identified in section 9.

How to make new input files
Input files can be made in DOS using the 'EDIT' command or in windows using NOTEPAD.

To make an input file in DOS:

To make an input file, for example, named INPUT.DIA in C, type:

C:\> edit INPUT.DIA
A blank screen appears.
On separate lines, type in the headings (shown in the example files) and the corresponding data. Make sure every line starts from the 1st space. In the data sections, data must be placed before the description, and separated from it by space(s) or tab(s). The description is only for information and is not used by the model, so can be omitted if desired.

Once the data entering is complete, click 'file' and then 'save'.

To make an input file using NOTEPAD:

Open NOTEPAD, and type the heading and data in exactly the same format as described above for DOS. Once complete, save it as INPUT.DIA in the same directory as the model program files.

2.5 Weather data files
These are labelled as *.met*. These are in a fairly strict format – see section 4.3. They must include complete years of data to cover the start and end of simulations. Part year weather data files will cause the model to fail.

2.6 The important output files and how to read them.
The key output files are

> *_DailyOutput.dat* file
> *_Mktyd.dat* file.

The model also outputs the following irrigation and fertilisation reports detailing when irrigation and fertilisations have taken place.

_IrrigationReport.dat
_FertilisationReport.dat
_InorgFertOptimisation01.dat

The Prefix of all output files comes from the data file name. If the input file is called Test.dia the output files will be prefixed, i.e.

Test_DailyOutput.dat

All these files can be read in readers such as MS NOTEPAD but to make the files readable WORD WRAP should be switched off. A tool has been made in EXCEL to ease the reading of the main Daily Output file and to provide summary graphs and tables – see 2.7.

The data contained in these output files is described in more detail in section 6 of this guide.

2.7 The Excel tool to read the data in the Daily Output file.

All the output files can be read using NOTEPAD as long as WORD WRAP is switched off. A utility has been designed in EXCEL to read the main output file - **_DailyOutput.dat* - which summarises the growth of crops and the amounts of nitrogen lost. It provides simple graphics and tabular format output:

ReadFile(rev).xls

Open this file and it will present a menu screen. Click on the 'Select File to Open' button and select the Daily Output file you wish to read, e.g.

Test_DailyOutput.dat

Macros within the program will re-format and sort through the files looking for harvest events and the last date of simulation. The time taken will depend on the length of the model run. Four worksheets will be created.

- Graph
- Summary Table
- Harvest Data
- Data

- GRAPH
Contains three graphs, one plotting daily dry matter yield vs time, a second plotting daily leaching against time and a third with cumulative leaching. These graphs can be edited to suit.

- SUMMARY TABLE
This contains the main output data from the model for the last day of the

simulation. It contains a range of data, some relating to that particular day and some relating to the cumulative period from the beginning of the simulation.

Example output in Summary Table

DayNo	1994365	day no of the last day of the simulation
Date		calendar date
Crop	Fallow	crop at time simulation finished
Dry_Weight	0.00	total Dry Weight of crop (if present) (t/ha)
N_Uptake	0.00	daily N uptake – from soil (kg/ha)
Nuptake_per_Crop	0.00	cumulative N uptake from soil on a crop basis (kg/ha)
cropBased_N_offtake	0.00	cumulative N uptake and N fixed from the air on a crop basis (kg/ha)
N_MineralFert	0.00	inorganic fertiliser applied (kg/ha)
N_via_Irrig	0.00	N via irrigation water (kg/ha)
N_OrganicFert	0.00	N in organic fertiliser (kg/ha)
Soil_N_90cm	88.20	mineral N in 0 to 90cm soil depth (kg/ha)
Nup_Below90cm	0.00	N uptake from below 90cm soil depth (kg/ha)
N_Fixed	0.00	daily N fixation (kg/ha)
SOM_N_Mineralised	-0.15	daily total mineralised N (kg/ha)
SMB_N	60.00	N in Soil Microbial Biomass pool (kg/ha)
cumu_SMB_N_min	-21.90	cumulative mineralised N from Soil Microbial Biomass pool (kg/ha)
Cumu_AOM_N_min	0.45	cumulative mineralised N from Added Organic Matter pool (kg/ha)
cumu_SOM_N_min	99.10	cumulative mineralised N from Soil Organic Matter pool (kg/ha)
Leaching	1.06	daily N leaching at 90cm soil depth (kg/ha)
Gaseous_Loss	0.00	daily gaseous loss (kg/ha)
SMD_90cm	0.00	soil moisture deficit down to 90 cm soil depth (cm)
Marketable_Yield	0.00	marketable yield (t/ha)
Gross_margin	0.00	gross margin (currency unit/ha)
Marketable_N_offtake	10.30	N offtake in the marketable parts (kg/ha)
N_Removed	1.47	cumulative N removed via residue/mowing (kg/ha)
cumu_Nuptake	27.60	cumulative N uptake (only from soil) (kg/ha)
cumu_Nup_Below90cm	0.56	cumulative N uptake from below 90cm depth (kg/ha)
cumu_N_offtake	27.60	cumulative N offtake (includes N Fixation) (kg/ha)
cumu_MineralFert	0.00	cumulative applied inorganic fertilisers (kg/ha)
cumu_N_via_irrig	0.00	cumulative N via irrigation water (kg/ha)
cumu_N_OrganicFert	0.00	cumulative N in applied organic fertilisers (kg/ha)
cumu_Fixed_N	0.00	cumulative N from fixation (kg/ha)
cumu_N_Mineralised	77.60	cumulative N mineralised (kg/ha)
cumu_Leaching_90cm	67.00	cumulative N leaching at 90cm soil depth (kg/ha)
cumu_Gaseous_loss	1.28	cumulative gaseous loss (kg/ha)
cumu_Gross_Margin	4010.00	cumulative gross margin (currency unit/ha)
Number of Days in Simulation	365.00	number of days in simulation
Days when leaching above >0.1 kg/ha	102.00	number of days when leaching above 0.1 kg/ha per day

% Time leaching >0.1 kg/ha	27.95	% of days when leaching > 0.1 kg/ha
Days exceed EU mg/litre Limit	239.00	number of days when nitrate concentration in water greater than the 50 mg/l EU limit
%Time exceed EU mg/litre limit	65.48	% of days when leaching exceed the EU limit

- HARVEST DATA

Presents the same data as in the summary table for major events during the growth of each of the cash crops, such as harvesting and fertilising.

- DATA

This presents the output data for the model in Excel sheet format and can be scrolled through to find data for any particular date. .

> **NOTE** – For this MACRO to operate the decimal separator should be a full stop.   It will not operate properly with a comma as the separator.

Saving Files

Use SAVE AS to save the data as an *.xls   Excel format spreadsheet. DO NOT save the file in *.dat format as it will no longer be readable using this tool.

2.8 If you cannot get the model to run.

- *Check you have all the model input files and they are in the same directory as the model, see 2.2.*
- *Check that the *.dia files have the data in the correct format and in the correct sequence. Common errors include dates being incorrectly labelled or out of sync.*
- *Check that the file contains the minimum information as listed in test1.dia – it is very easy to delete the heading lines or questions relating to the number of important events such as organic and inorganic fertilisations.*
- *Check that you have correct weather data (see section 5).*
- *Does the model run the example files OK. If yes, the problem is with your files. If not, check that all the program files are available.*
- *Check the version number of the model used – look at the bottom of the _Mktyd.dat file.*
- *Send an Email to eurotaten@.warwick.ac.uk including all the input files used.*

3. THE BASIC ORGANISATION OF THE INPUT FILE

The EU-ROTATE_N model requires one input file only. The input file contains information on the site characteristics, names of weather files, soil properties, and

cropping parameters together with the initial conditions. All the information must be provided in the input file in the following order.

1. Site properties
2. Simulation period
3. Weather files
4. Switch for winter climate simulation
5. Soil properties
6. Initial conditions
7. Soil mineral N updates
8. Previous crop residue incorporation
9. Number of crops in rotation (from fertilisation to residues incorporation)
10. Fertilisation
11. Irrigation
12. Crop data
13. Crop residues

> N.B. Ensure that the 1st letter of the headings is in UPPER case and the rest are in LOWER case.
>
> These headings appear in the INPUT FILE and **SHOULD NOT BE EDITED** or appended to as it will cause the model to fail.

For **multiple crops in rotations** sections 10-13 are repeated, each crop having its own fertilizer, irrigation, crop data and residue incorporation. The number of crops in the rotation is identified in section 9.

All dates in the input file are in Julian days. The data types are classified as integer type (Int), real type (Real) and string/character type (string).

4. THE INPUT FILE

Examples are shown in Appendix 3 (Test1.dia, the simplest file to run the model) and Appendix 4 (Complex.dia, which includes examples of a range of triggers and events that the model can use).

4.1 Site properties

In this section, four lines are required. The first line specifies the print out control. The second and third lines are the latitude (^{o}) and altitude (m) of the site, and the final line is the N deposition rate (kg-N/ha/year).

Site properties

Brief	(string) Print out control*
60.77	(real) Latitude (^{o})**
127.0	(real) Altitude (m)
36.5	(real) N deposition (kg/ha/year)

4.2 Simulation period

In this section only two lines are required to specify the start and end dates of the simulation.

Simulation period

1994001	(int) Simulation start date*
1994365	(int) Date when simulation ceases*

* The date used in the model is the Julian day, e.g. 1st Jan 1994=1994001.

4.3 Weather files

Three lines are required in this section. The first line is the weather data file to be used for the simulation, which must contain enough daily weather to allow the model to run. The second line specifies the number of years of weather data contained in the file. The name of the weather data file also has to be included in the third line (This second entry of the name will allow the addition of a further model trigger in the future). Each weather data file should start with the first of January of the year in which the simulation starts, and it must contain complete years of data until the end of the simulation. **Part year weather data files will cause an error.** For format of the weather data files see section 5.

Weather files

weather.met	(string) Filename of weather data*
12	(int) No of weather data years
weather.met	(string) Filename of weather data*

* Ensure that the length of the weather file name does not exceed 20 characters.

4.4 Switch for winter climate simulation

This switch is used to switch the winter climate simulation on or off. This feature would be used in cooler climates where it is known that the soils freeze and are covered by accumulations of snow during the winter. When the winter climate simulation is on a selection has to be made for the broad soil type.

Switch for winter climate simulation

Yes	(string) Switch for winter climate simulation*
1	(int) Soil type**

* Ensure that the 1st letter of the option is in UPPER case and the rest are in LOWER case.
** Two options for the soil type: 1 for sandy loam soil and 2 for clay soil.

Otherwise

Switch for winter climate simulation

No   (string) Switch for winter climate simulation*

> * Ensure that the 1st letter of the option is in UPPER case and the rest are in LOWER case.

4.5 Soil properties

The number of the lines required in this section varies, depending on whether the surface runoff simulation is on or off, and the number of sample soil layers.

The section starts with the specification of whether the surface runoff is on or off. If the surface runoff is on, the following information has to be provided.

Soil properties

Yes	(string) Runoff simulation*
CT	(string) Land use treatment**
Good	(string) Hydrologic condition***

> * Two options for this control: Yes or No. Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case.
> ** Four options for the land use treatment: SR, SR+CT, CNT, CNT+CT. (SR, CT and CNT represent straight rows, conservation tillage and contoured cultivation, respectively). Ensure that all letters are UPPER case.
> *** Two options for the hydrologic condition: Good or Poor. Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case.

Otherwise

Soil properties

No   (string) Runoff simulation

Other information includes:

9.0	(real) Readily evaporable water (mm)*
0.1	(real) Soil depth subject to evaporation (m)
0.0	(real) Maximum rooting depth due to soil barrier (cm)**
30	(int) Sampled layer size (cm)
3	(int) No of sampled layers
0.29	(real) Volumetric soil water content at field capacity (1st soil layer sampled)
0.11	(real) Volumetric soil water content at permanent wilting point (1st soil layer sampled)
0.48	(real) Volumetric soil water content at saturation (1st soil layer sampled)
0.0	(real) drainage coefficient (0.0 to 1.0, set 0.0 if unknown)***

(for sampled soil layers more than 1, add the same information for other layers)

0.19	(real) Clay content (1st soil layer sampled)
0.37	(real) Sand content (1st soil layer sampled)
1350.0	(real) Soil bulk density (kg/m^3) (1st soil layer sampled)
6.5	(real) Soil pH (1st soil layer sampled)
0.04	(real) Organic matter content (1st soil layer sampled)

(for sampled soil layers more than 1, add the same information for other layers)

Finally the CN ratio of the soil organic matter needs to be entered

| 10.0 | (real) C/N ratio |

---

* The values of readily evaporable water (REW) and total evaporable water (TEW) when the evaporation layer has been initially completely wetted and drained. The values are for a soil depth subject to evaporation (Ze) of 10 cm, and for different soil types (after Allen et al., 1998):

	Soil water characteristics			Evaporation parameters	
	θ_{FC}	θ_{WP}	$(\theta_{FC}-\theta_{WP})$	Amount of water that can be depleted by evaporation	
				Stage 1 REW	Stages 1 and 2 TEW ($Z_e = 0.10$n
	m^3/m^3	m^3/m^3	m^3/m^3	mm	mm
Sand	0.07 - 0.17	0.02 - 0.07	0.05 - 0.11	2 - 7	6 - 12
Loamy sand	0.11 - 0.19	0.03 - 0.10	0.06 - 0.12	4 - 8	9 - 14
Sandy loam	0.18 - 0.28	0.06 - 0.16	0.11 - 0.15	6 - 10	15 - 20
Loam	0.20 - 0.30	0.07 - 0.17	0.13 - 0.18	8 - 10	16 - 22
Silt loam	0.22 - 0.36	0.09 - 0.21	0.13 - 0.19	8 - 11	18 - 25
Silt	0.28 - 0.36	0.12 - 0.22	0.16 - 0.20	8 - 11	22 - 26
Silt clay loam	0.30 - 0.37	0.17 - 0.24	0.13 - 0.18	8 - 11	22 - 27
Silty clay	0-30 - 0.42	0.17 - 0.29	0.13 - 0.19	8 - 12	22 - 28
Clay	0.32 - 0.40	0.20 - 0.24	0.12 - 0.20	8 - 12	22 - 29

Allen R.G., Pereira L.S., Raes D. and Smith, M. (1998), Crop evapotranspiration. Guidelines for computing crop water requirements. *FAO Irrigation and Drainage Paper* **56**. FAO, Rome.

** For no soil barriers for root growth, set the value to 0.0.
*** Drainage coefficient values range from 0.0 to 1.0. A value of 1 allows all excess water above field capacity to drain to the lower level. (similar to N_ABLE) Clay soils may have a drainage coefficient closer to 0. If unknown set to 0. The drainage coefficient is then calculated from

Ritchie, J.T. (1998). Soil water balance and plant water stress. G.Y. Tsuji et al. (eds):
in Understanding options for agricultural production p. 41-54.*

4.6 Initial conditions
The initial soil volumetric water contents and mineral soil N contents for the sampled soil layers need to be specified here.

Initial conditions

| 0.29 | (real) 1st layer soil volumetric water content (cm^3/cm^3)(layers as previous inputs) |

(for sampled soil layers more than 1, add the same information for other layers)

| 10.0 | (real) 1st layer soil mineral N content (kg N/ha) (layers as previous inputs) |

(for sampled soil layers more than 1, add the same information for other layers)

4.7 Soil mineral N updates

Soil mineral N updates during the simulation are possible. To do so, the following information needs to be entered here.

Soil mineral N updates

1	(int) number of soil N updates (layers as previous inputs)
1994002	(int) date of soil N Update
50.0	(real) Mineral soil_N (kg N/ha) (1st soil layer sampled)

(for sampled soil layers more than 1, add the same information for other layers)

If there is no soil N update during the simulation, then

Soil mineral N updates

| 0 | (int) number of soil N updates (layers as previous inputs) |

4.8 Previous crop residue incorporation

The information required in this section is as follows.

Previous crop residue incorporation

1994110	(int) Time of incorporation of previous crop residues
Plough	(string) Method of incorporation*
25.0	(real) Depth of incorporation (cm)
5000.0	(real) Residue dry weight (kg/ha)
26	(int) Residue type from crop residue table**
0.035	(real) N concentration of residue dry weight

> * The options for the incorporation method: Mix, Plough, Mow. Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case.
> ** Residue type from the crop residue table is listed in Appendix 1.

4.9 Number of crop in rotation

Only one line is required to specify the number of crops in the rotation in this section.

Number of crop in rotation (from fertilisation to residues incorporation)

| 1 | (int) No of crops in rotation* |

> * If this number is smaller than the crops specified later in the input file, then the model simulates fallow crops after the specified number of crops here has been reached. However, if this number is greater than the crops specified in the input file, the simulation fails.

4.10 Organic Manures and Fertilisers

The information for fertilisation and irrigation is more complicated as there are triggers in these sections.

There are two blocks of input, the first for organic fertilisations and the second for inorganic fertilisations. If there are no applications of organic fertiliser set the number of organic fertilisation events to 0.

Fertilisation

0   (int) Number of organic fertilisation events

Otherwise the number of organic fertilisation events needs to be specified

Fertilisation

2   (int) Number of organic fertilisation events

Within each block there is a current limit of 40 in the number of fertilisations that can take place (Each event type counts as one plus one for each date when fertiliser is applied). It is possible that with the Target triggers operating this limit will be exceeded – a warning will be given and the model will stop operating. The events can allow changes in the type of fertiliser material. All fertilisation events need to be associated with a crop.

The following event type is available for organic fertilisation

✦ **Fixed** – This just applies a fixed amount of N in organic fertiliser. Note: measured as kg/ha fresh weight of organic material applied (NOT N). The cost of this is also expressed as cost per kg of material based on Fresh weight.

Fixed	(String) Event type (Fixed, KNS or Target)*
1994118	(int) Fertilisation date
1000.0	(real) Amount of fresh weight to apply (kg/ha)
10	(int) Organic fertiliser type (from organic fertilisers table)**
1.0	(real) Cost of fertiliser (currency unit/kg)
10.0	(real) Cost of applying fertiliser (currency unit/ha)
Plough	(String) Incorporation Method*
1	(int) Incorporation delay (number of days after fertilisation)
30.0	(real) Incorporation depth (cm)

Organic fertiliser type

1 cattle deep-litter manure	2 cattle manure
3 cattle slurry	4 cattle urine
5 pig deep-litter manure	6 pig manure
7 pig slurry	8 pig urine
9 sheep/goat deep-litter manure	10 horse deep-litter manure
11 poultry deep-litter manure	12 poultry manure
13 turkey deep-litter manure	14 duck/goose deep-litter manure
15 green-waste compost	16 sewage sludge
17 potato liquid waste	18 oilseed-rape cake fertiliser

4.11 Inorganic Fertilisers

For the application of inorganic fertilisers the first line also needs to specify the number of fertilisation events, in this case 4:

4   (int) Number of inorganic fertilisation events

The following functionalities (Event types) are available for the inorganic fertilisation:

⊕ **Fixed** – This just applies a fixed amount of N in inorganic fertiliser. (Note measured as kg/ha N not product) The cost of this is also expressed as cost per kg N.

Fixed	(String) Event type (Fixed, KNS or Target)*
1994134	(int) Fertilisation Date
5.0	(real) Amount of fertiliser to apply (kg/ha)
7	(int) Inorganic fertiliser type (from inorganic fertilisers table)**
1.0	(real) Cost of fertiliser (currency unit/kg)
10.0	(real) Cost of applying fertiliser (currency unit/ha)
Mix	(String) Incorporation Method*
2	(int) Incorporation delay (number of days after fertilisation)
30.0	(real) Incorporation depth (cm)

Inorganic fertiliser type

1 Ammonium Nitrate	2. Ammonium Phosphate
3 Ammonium Sulphate	4 Compound fertiliser (0%NO_3, 100%NH_4)
5 Compound fertiliser (35%NO_3, 65%NH_4)	6 Compound fertiliser (50%NO_3, 50%NH_4)
7 Potassium Nitrate	8 Urea
9 Urea Ammonium Nitrate	10 Urea Ammonium Sulphate

⊕ **KNS -** This trigger operates on a daily basis between the two dates specified in the input file. The amount of N contained in the plant and in the soil as mineral N to a specified soil depth and 30 cm depth will be compared with the Target values. Both the specified soil depth and the Target values in the crop table can be seen in Appendix 2. The trigger will supply the maximum amount of fertiliser that it is allowed by the limits set in the input file. If the maximum amount of fertiliser is applied the trigger is inactivated for a given period of time before it retests nitrogen requirement.

KNS	(String) Event type (Fixed, KNS or Target)*
1994181	(int) Inorganic fertiliser trigger enable date
1994240	(int) Inorganic fertiliser trigger disable date
7	(int) Inorganic fertiliser type (from inorganic fertilisers table)
1.0	(real) Cost of fertiliser (currency unit/kg)
10.0	(real) Cost of applying fertiliser (currency unit/ha)
10.0	(real) Minimum fertiliser amount
100.0	(real) Maximum fertiliser amount
5	(int) Number of days that trigger is disabled after fertilization
Mix	(String) Incorporation Method*
0	(int) Incorporation delay (number of days after fertilisation)
30.0	(real) Incorporation depth (cm)

* Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case. For KNS event type, it can be either KNS or Kns.

⊕ **Target –** If used as part of the German Nmin system this trigger should only be used on a single day, i.e. on day "X" and off on day "X+1". The amount of soil mineral N in the rooting depth and in the surface soil will be compared with the Target values in the crop table. The trigger will supply the maximum amount of fertiliser that it is allowed by the limits set in the input file. A delay for the topdressing can be specified. This trigger will be immediately disabled after use. The trigger could also be used as part of a date range like the KNS trigger but it will only fertilise once.

Target	(String) Event type (Fixed, KNS or Target)*
1994135	(int) Inorganic fertiliser trigger enable date
1994136	(int) Inorganic fertiliser trigger disable date
7	(int) Inorganic fertiliser type (from inorganic fertilisers table)
1.0	(real) Cost of fertiliser (currency unit/kg)
10.0	(real) Cost of applying fertiliser (currency unit/ha)
10.0	(real) Minimum fertiliser amount
100.0	(real) Maximum fertiliser amount
0	(int) Delay (in days) before top dressing (if necessary)
Plough	(String) Incorporation Method*
0	(int) Incorporation delay (number of days after fertilisation)
30.0	(real) Incorporation depth (cm)

* Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case.

4.12 Irrigation

Up to 500 irrigation amounts can be applied and these can be triggered by a whole range of Triggered events – for example it is possible to specify a fixed irrigation after planting followed by either Evapo or Content triggers. The triggers switch on and off at specified dates so it is possible to use different thresholds at different stages of crop growth by using two water content triggers one after the other. It is also possible to use different irrigation methods for each event.

This section starts with the heading

 Irrigation

and is then followed by the number of irrigation events applied in the simulation

3	(int) Number of irrigation events

There are three types of irrigation triggers

✦ **Fixed** – The trigger applies a fixed amount on a certain day by a certain method

Fixed	(String) Event type (Fixed, Content or Evapo)*
1994010	(int) Irrigation date
Sprinkler	(String) Irrigation method**
1.0	(real) Fraction of wetted soil surface (fw)***
25.0	(real) Amount (mm)
0.0001	(real) N conc in irrigation water (g/l)

* Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case.
** The choices for irrigation method are: Sprinkler, Drip and Furrow. Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case.
*** Typical values of wetted soil surface fraction (fw) by irrigation (after Allen et al., 1998)

Wetting event	f_w
Sprinkler irrigation	1.0
Furrow irrigation (every furrow), narrow bed	0.6 – 1.0
Furrow irrigation (every furrow), wide bed	0.4 – 0.6
Furrow irrigation (alternated furrows)	0.3 – 0.5
Drip irrigation	0.3 – 0.7

✦ **Evapo** – The trigger calculates cumulative evapotranspiration and irrigation is triggered when this reaches a certain value.

Evapo	(String) Event type (Fixed, Content or Evapo)*
1994010	(int) Evapo trigger enable date**
1994180	(int) Evapo trigger disable date**
Sprinkler	(String) Irrigation method*
1.0	(real) Fraction of wetted soil surface
25.0	(real) Amount (mm)
0.0001	(real) N conc in irrigation water (g/l)
50.0	(real) Trigger evaporation sum threshold (mm)

* Ensure that the 1st letter of the option is UPPER case and the rest are LOWER case.
** An important principal used throughout for the triggers is when they operate i.e

1999213	Date when irrigation is enabled
1999214	Date when irrigation is disabled

Means the trigger is tested on Day 213 and only subsequent triggers can start on Day 214. If another trigger is listed that is enabled on the same day there is a conflict between triggers and it is always the first one in the file that operates.

✦ **Content** – The trigger tests the amount of available water in the soil down to a specified depth – if this is below a certain amount an irrigation event is triggered. The input has been modified to allow insertion of the trigger deficit (in mm) measured to a certain depth.

Content	(String) Event type (Fixed, Content or Evapo)*
1994181	(int) Content Trigger enable date
1994240	(int) Content Trigger disable date
Sprinkler	(String) Irrigation method*
1.0	(real) Fraction of wetted soil surface (0-1)
25.0	(real) Amount (mm)
0.0	(real) N conc in irrigation water (g/l)
50.0	(real) Trigger critical deficit (mm)
100.0	(real) Lower Boundary depth for deficit (cm)

* Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case.

4.13 Crop data
Crop data contains information about the simulated crop species, spacing, dates and dry weights at planting and harvest, and pricing and variable costs for calculating the gross margin.

Cash crops

Crop data	
26	(int) Crop type from crop table *
13.0	(real) Row width (cm)
2.0	(real) Plant spacing (cm)

1994121	(int) Planting date
170.0	(real) Dry weight at planting kg/ha
2.0	(real) %N in transplant (0.0 if not known)
1	(int) Number of harvests **
1994244	(int) Harvest date **
9.35	(real) Dry weight of total plant t/ha (target)
0.0	(real) Weight for DM reduction due to water stress (0.-100.)***
0.0	(real) Marketable min fresh weight per head (g/head) ****
0.0	(real) Marketable max fresh weight per head (g/head) ****
0.0	(real) CV - variability of marketable product wt. (0-1)****
1500.0	(real) Price for marketable yield (currency unit/t)
300.0	(real) Variable costs independent of marketable yield (currency unit/ha)
20.0	(real) Variable costs dependent on marketable yield (currency unit/t)

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* **Crop type numbers are listed in Appendix 1.**

** Up to 50 harvest events are allowed for cash crops. The number of events has to be specified in the crop part of the input file. Each harvest is then defined by a date and the DW amount of crop removed at each harvest. The section is ended by the date of final harvest and the target DW in tonnes per ha dry wt.

*** 0.0 means that water stress is not considered in the plant growth, while 100.0 means the growth is reduced in the same proportion as transpiration.

**** The maximum and minimum weights are used for crops that have a single harvestable product per plant,   thereby enabling different marketable constraints to be set. These inputs will be **ignored** for the following crops:

Broad_beans	Brussels_Sprouts	Calabrese
French_beans	Maize_grain	Peas
Potato_Early	Potato_Late	Radish
Red_Beet	Spinach	Sugar_Beet
Swede	Turnip	Wheat
Lamb's_Lettuce	Cucumber_for_pickling	Kale
Tomato	Oat	Artichoke
Parsley	Sweetcorn	Oil_Seed_Rape
Spring_onion	Processing_Tomato	Barley
Rye_and_Triticale		

The CV (coefficient of variation) is used to allow crops with a particular fertilization regime to have a range of harvested sizes. The lower the CV the sharper the boundary will be between sufficient and insufficient N for marketable yield. The value can be set to between 0 and 1, i.e. a value of 0.3 means a coefficient of variation of 30%.

Multiple Harvested Crops
For example, a crop with three harvests needs the following information to be provided:

Crop data

26	(int) Crop type from crop table
13.0	(real) Row width (cm)
2.0	(real) Plant spacing
1994121	(int) Planting date
170.0	(real) Dry weight at planting kg/ha
2.0	(real) %N in transplant (0.0 if not known)

3	(int) No of harvests
1994160	(int) Date of 1st harvest
1.0	(real) Dry weight removed at the 1st harvest (t/ha)
1994200	(int) Date of 2nd harvest
2.0	(real) Dry weight removed at the 2nd harvest (t/ha)
1994250	(real) Date of the final harvest
8.5	(real) Final dry weight (t/ha)
0.0	(real) Weight for DM reduction due to water stress (0-100)
0.0	(real) Marketable max fresh weight per head (g/head)
0.0	(real) Marketable min fresh weight per head (g/head)
0.0	(real) CV - variability of marketable product wt.
1500.0	(real) Price for marketable yield (currency unit/t)
300.0	(real) Variable costs independent of marketable yield (currency unit/ha)
20.0	(real) Variable costs dependent on marketable yield (currency unit/t)

Cover crops, fertility building crops and mowing

For cover crops the information required is different from cash crops. The crops can also be undersown. It is difficult to know how effective the undersown or direct planted crop will perform so growth needs to be defined as Bad, Medium or Good. The number of mowings needs to be entered and a date for each mowing event. There is a maximum of 50 mowings. This section is ended by the date of final harvest. At each mowing 50% of the above ground part of the crop is removed. Account can be taken of the effect of water stress and any potential income, costs.

For an undersown cover crop with two mowings:

Crop data

67	(int) Crop no from crop table
10.0	(real) Row width (cm)
10.0	(real) Plant spacing (cm)
1999244	(int) Date of planting
Undersown	(string) Sowing method*
Medium	(string) Growth as undersown crop**
Medium	(string) Growth as main crop**
2	(int) No of Mowing
2000156	(int) Date of 1st mowing
2000217	(int) Date of 2nd mowing
2001059	(int) Date of harvest
0.0	(real) % DM reduction due to water stress
0.0	(real) Price for marketable yield (currency unit/t)
200.0	(real) Variable costs independent of marketable yield
0.0	(real) Variable costs dependent on marketable yield

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* Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case.

** Growth as undersown or main crop can be: Bad, Medium, Good. Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case.

For a direct planted crop, provide the following information:

Crop data

67	(int) Crop no from crop table
10.0	(real) Row width (cm)
10.0	(real) Plant spacing (cm)
1999244	(int) Date of planting
Non-undersown	(string) Sowing method*
20.0	(real) Dry weight at planting (kg/ha)
2.0	(real) %N in transplant
Medium	(string) Growth as main crop*
2	(int) No of Mowing
2000156	(int) Date of 1st mowing
2000217	(int) Date of 2nd mowing
2001059	(int) Date of harvest
0.0	(real) % DM reduction due to water stress
0.0	(real) Price for marketable yield (currency unit/t)
200.0	(real) Variable costs independent of marketable yield
0.0	(real) Variable costs dependent on marketable yield

> * Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case.

4.14 Crop residues

The information required in this section includes the date, method and depth of incorporation, together with the percentage of crop residues removed.

Crop residues

1994285	(int) Crop debris incorporation date
Plough	(string) Method of incorporation*
25.0	(real) Depth of incorporation (cm)
10.0	(real) Percentage of crop residues removed

> * The options for the incorporation method: Mix, Plough, Mow. Ensure that the 1st letter of the option is UPPER case and the rest are in LOWER case.

5 WEATHER DATA FILE

Weather data file contains the daily weather records for the years specified in the input file. The daily met information required by the model includes:

- Julian day of the year
- Minimum air temperature (^{o}C)
- Mean air temperature (^{o}C)
- Maximum air temperature (^{o}C)
- Precipitation (mm)
- Mean relative humidity (%)
- Maximum relative humidity (%)
- Minimum relative humidity (%)
- Wind speed (m s^{-1})
- Height where the wind speed is measured (m)
- Sunshine hours (hour)

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- Global radiation (MJ m^{-2} day^{-1})
- Reference evapotranspiration (mm)

The user must provide the following information: Julian day of the year, minimum air temperature, mean air temperature, maximum air temperature, precipitation, mean relative humidity, and either sunshine hours or global radiation.

The rest of the information is optional. If the user cannot provide, set -100.0 to the corresponding places.

If both sunshine hours and radiation are provided radiation values will be used in preference. Complete datasets will provide better estimates of crop evapotranspiration. Knowing max and min relative humidity together, and wind speed at a particular height will improve the estimation of evapotranspiration.
If there are gaps in radiation indicated by -100 then the sunshine hours figure will be used on that date.

Note: If Reference ET_0 Evapotranspiration figures are available as calculated according to standard Penman Monteith equations then the models mandatory data requirement is reduced. However it still has to include -100 as an indicator of missing values. Mean Air Temperature, Maximum Air Temperature, Minimum Air Temperature, Wind Speed, and Precipitation, will still be required.

Richard G. Allen Luis S. Pereira Dirk Raes, Martin Smith. Crop evapotranspiration - Guidelines for computing crop water requirements - FAO Irrigation and drainage paper 56. Water Resources, Development and Management Service FAO - Food and Agriculture Organization of the United Nations, Rome, 1998

NB. FORMAT OF FILE

✦ Each year starts with a line with a 4-digit year number in the beginning.

✦ All the daily information should be put in the same line, and the numbers must be separated by space(s) or tab(s). The data type for Day is integer, while real for others.

✦ The yearly weather records must be complete. i.e. from 1 Jan to 31 Dec.

✦ **The number of days in each year of weather data must match the corresponding year in the input file. Therefore, when running simulations in leap years the associated weather data must contain 366 days.**

Sample weather data file

1989	Day	Tmin	Tmean	Tmax	Preci	RHmean	RHmax	RHmin	Vwind	Zwind	Tsun	Rs	Eo
	1	-1.1	-0.2	0.5	0.0	97.0	-100.0	-100.0	0.6	2.0	-100.0	1.4	-100.0
	2	-0.5	-0.3	0.2	0.7	96.0	-100.0	-100.0	0.9	2.0	-100.0	0.3	-100.0
	3	-1.5	-1.0	-0.3	0.0	90.0	-100.0	-100.0	2.4	2.0	-100.0	0.7	-100.0
	4	-1.7	-1.9	-0.6	0.0	87.0	-100.0	-100.0	4.1	2.0	-100.0	0.9	-100.0
	5	-2.7	-0.2	1.6	0.0	98.0	-100.0	-100.0	1.8	2.0	-100.0	1.0	-100.0
	6	-0.3	1.5	2.2	2.2	98.0	-100.0	-100.0	3.6	2.0	-100.0	0.4	-100.0

7	0.0	2.1	4.3	1.1	97.0	-100.0	-100.0	3.9	2.0	-100.0	0.3	-100.0
8	0.6	4.4	6.5	8.8	97.0	-100.0	-100.0	2.9	2.0	-100.0	1.3	-100.0
9	1.3	4.1	6.7	2.5	97.0	-100.0	-100.0	3.6	2.0	-100.0	0.5	-100.0
10	1.4	4.8	7.1	0.4	97.0	-100.0	-100.0	4.8	2.0	-100.0	0.5	-100.0
11	3.6	7.1	7.5	3.2	97.0	-100.0	-100.0	4.8	2.0	-100.0	0.3	-100.0
12	6.7	6.3	7.5	0.7	95.0	-100.0	-100.0	5.0	2.0	-100.0	1.9	-100.0
13	4.4	4.3	6.6	2.3	95.0	-100.0	-100.0	3.3	2.0	-100.0	2.5	-100.0

6 THE OUTPUT FILES

The Prefix of all output files comes from the data file name. If the input file is called Test.dia the output files will be prefixed, i.e.

Test_DailyOutput.dat

All these files can be read in readers such as MS NOTEPAD but to make the files readable WORD WRAP should be switched off. A tool has been made in EXCEL to ease the reading of the main Daily Output file and to provide summary graphs and tables.

The main output files are

_DailyOutput.dat file
_Mktyd.dat file.

The model also outputs following irrigation and fertilisation reports detailing when irrigation and fertilisations have taken place.

_IrrigationReport.dat
_FertilisationReport.dat
_InorgFertOptimisation01.dat

In the file *_DailyOutput.dat*, the following results are output on a daily basis.

Date	: Date
Crop	: crop name
Dry_Weight	: cumulative shoot dry weight (t/ha)
N_Uptake	: daily N uptake (kg/ha)
Nuptake_per_Crop	: cumulative N uptake from the soil on a crop basis (kg/ha)
cropBased_N_offtake	: cumulative N uptake plus N fixed from the air on a crop basis (kg/ha)
N_MineralFert	: inorganic fertiliser applied (kg/ha)
N_via_Irrig	: N via irrigation water (kg/ha)
N_OrganicFert	: N in organic fertiliser (kg/ha)
Soil_N_90cm	: soil mineral N in 0-90cm soil layer (kg/ha)
Nup_Below90cm	: N uptake from below 90cm soil depth (kg/ha)
N_Fixed	: daily N fixation (kg/ha)
SOM_N_Mineralised	: daily total mineralised N (kg/ha)
SMB_N	: N in Soil Microbial Biomass pool (kg/ha)
cumu_SMB_N_min	: cumulative mineralised N from Soil Microbial Biomass pool (kg/ha)
Cumu_AOM_N_min	: cumulative mineralised N from Added Organic Matter pool (kg/ha)
cumu_SOM_N_min	: cumulative mineralised N from Soil Organic Matter pool (kg/ha)
Leaching	: daily N leaching at 90cm soil depth (kg/ha)

Gaseous_Loss	: daily gaseous loss (kg/ha)	
SMD_90cm	: soil moisture deficit down to 90 cm soil depth (cm)	
Marketable_Yield	: marketable yield (t/ha)	
Gross_margin	: gross margin (currency unit/ha)	
Marketable_N_offtake	: N offtake in the marketable parts (kg/ha)	
N_Removed	: cumulative N removed via residue/mowing (kg/ha)	
cumu_Nuptake	: cumulative N uptake from the soil (kg/ha)	
cumu_Nup_Below90cm	: cumulative N uptake from below 90cm depth (kg/ha)	
cumu_N_offtake	: cumulative N offtake including N fixed (kg/ha)	
cumu_MineralFert	: cumulative applied inorganic fertilisers (kg/ha)	
cumu_N_via_irrig	: cumulative N via irrigation water (kg/ha)	
cumu_N_OrganicFert	: cumulative N in applied organic fertilisers (kg/ha)	
cumu_Fixed_N	: cumulative N from fixation (kg/ha)	
cumu_N_Mineralised	: cumulative mineralised N (kg/ha)	
cumu_Leaching_90cm	: cumulative N leaching at 90cm soil depth (kg/ha)	
cumu_Gaseous_loss	: cumulative gaseous lass (kg/ha)	
cumu_Gross_Margin	: cumulative gross margin (currency unit/ha)	
Daily_WaterLeach_at90cm	: daily water leaching at 90 cm soil depth (mm)	

In the file _Mktyd.dat, the crop marketable yields are calculated using two different approaches depending on the type of crop. The single plant approach is used where each plant produces a single product, i.e. cauliflower producing a single curd. The model estimates the range of curd sizes and then applies the marketing criteria entered in the input file. The direct conversion approach is based on an empirical curvilinear relationship between available N and marketable yield. This approach is used for crops such as Brussels sprouts where there are several products (sprouts) per plant. See the scientific report.

Sample _Mktyd.dat file

_____

Crop	:	Cauliflower		
Date of planting	:	1994141		
Date of harvest	:	1994202		
Applied fertiliser (kg/ha)	:	0.0		
Plant population (/ha)	:	33333		
Dry matter at harvest (t/ha)	:	2.02		
Available N (kg/ha)=N in plant+N soil_90cm at harvest	:	57.14	46.95	10.18

The following items are calculated using two different approaches......

**** Direct conversion ****

Marketable head average (g/plant)	:	55.33
Marketable yield (t/ha)	:	1.84
Removed dry matter (t/ha)	:	0.18
Crop residues (t/ha)	:	1.83

**** Via single plant ****

Field head average (g/plant)	:	272.18
Marketable yield (t/ha)	:	0.00
Removed dry matter (t/ha)	:	0.00
Crop residues (t/ha)	:	2.02

(Plant lower & upper limits for 2nd approach are   :   600.0   2000.0   g/plant)
CV   :   0.3
gradeout (%)   :   100.0

Model chooses   : single plant approach
Crop residues dry matter left in field (t/ha)   :   2.02
Crop residues N concentration (%)   :   1.91
Crop residues N content (kg/ha)   :   38.56
Root mass left in field (t/ha)   :   0.84
Root mass N content (kg/ha)   :   8.39

++
Model version: v1.6   Croptable: v1.6   ResidueTable: v1.6   OrganicFertTable: v1.6   MineralFertTable: v1.6

Sample *_DailyOutput.dat file

Model   output

Date	Crop	Dry_Weight	N_Uptake	Nuptake_per_Crop	cropBased_N_offtake	N_MineralFert	N_via_Irrig	N_OrganicFert	Soil_N_90cm	Nup_Below90cm	N_Fixed	SOM_N_Mineralised	SMB_N
-	-	t/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
1998090	Fallow	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.03E+01	0.00E+00	0.00E+00	-2.89E-01	2.89E+01
1998091	Fallow	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.05E+01	0.00E+00	0.00E+00	-2.91E-01	2.90E+01
1998092	Fallow	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.08E+01	0.00E+00	0.00E+00	-2.92E-01	2.91E+01
1998093	Fallow	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.11E+01	0.00E+00	0.00E+00	-2.99E-01	2.92E+01
1998094	Fallow	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.14E+01	0.00E+00	0.00E+00	-2.77E-01	2.92E+01
1998095	Fallow	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.16E+01	0.00E+00	0.00E+00	-2.88E-01	2.93E+01
1998096	Fallow	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.19E+01	0.00E+00	0.00E+00	-2.88E-01	2.94E+01
1998097	Fallow	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E+01	0.00E+00	0.00E+00	-2.52E-01	2.95E+01
1998098	Fallow	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.23E+01	0.00E+00	0.00E+00	-2.25E-01	2.95E+01

cumu_SMB_N_min	Cumu_AOM_N_min	cumu_SOM_N_min	Leaching	Gaseous_Loss	SMD_90cm	Marketable_Yield	Gross_margin	Marketable_N_offtake	N_Removed	cumu_Nuptake	cumu_Nup_Below90cm	cumu_N_offtake
kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	cm	t/ha	Currency_Unit/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
-8.24E-02	0.00E+00	2.89E-01	0.00E+00	2.22E-02	3.86E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
-1.65E-01	0.00E+00	5.80E-01	0.00E+00	1.08E-02	6.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
-2.48E-01	0.00E+00	8.72E-01	0.00E+00	1.02E-02	5.57E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
-3.33E-01	0.00E+00	1.17E+00	0.00E+00	1.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
-4.12E-01	0.00E+00	1.45E+00	4.16E-15	2.68E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
-4.94E-01	0.00E+00	1.74E+00	1.20E-12	1.93E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
-5.75E-01	0.00E+00	2.02E+00	1.76E-11	1.76E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
-6.47E-01	0.00E+00	2.28E+00	1.50E-10	5.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
-7.10E-01	0.00E+00	2.50E+00	3.29E-07	7.71E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

cumu_MineralFert	cumu_N_via_irrig	cumu_N_OrganicFert	cumu_Fixed_N	cumu_N_Mineralised	cumu_Leaching_90cm	cumu_Gaseous_loss	cumu_Gross_Margin	Daily_WaterLeach_at90cm
kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	Currency_Unit/ha	mm
0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E-01	0.00E+00	2.22E-02	0.00E+00	0.00E+00
0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.15E-01	0.00E+00	3.30E-02	0.00E+00	-2.78E-16
0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.24E-01	0.00E+00	4.32E-02	0.00E+00	-1.39E-15
0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.38E-01	0.00E+00	5.32E-02	0.00E+00	-6.66E-15
0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E+00	4.16E-15	8.00E-02	0.00E+00	2.25E-14
0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E+00	1.20E-12	9.93E-02	0.00E+00	6.47E-12
0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E+00	1.88E-11	1.17E-01	0.00E+00	9.51E-11
0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.63E+00	1.69E-10	1.73E-01	0.00E+00	8.13E-10
0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.79E+00	3.29E-07	2.50E-01	0.00E+00	1.78E-06

7 BATCH FILE TO RUN THE MODEL

Several scenarios can be run at once using a batch file.

This file can be made up in DOS or in notepad and saved as a *.bat file such as JOB.BAT.

The example here will run 3 scenario files without the user's intervention. It should contain the following text:

```
@echo off
echo scenario1.dia | eu-rotate_n_1-6a.exe
echo scenario2.dia | eu-rotate_n_1-6a.exe
echo scenario3.dia | eu-rotate_n_1-6a.exe
echo done
```

The batch file can be executed by typing JOB in DOS or double click it in a window. Again, make sure the model executable and all the weather data and input files are in the correct directory.

A set of output files will be produced for each input file.

8 THE INTERNET VERSION

8.1 Getting Started

Access to the internet version is via

www.warwick.ac.uk/go/eurotaten

The site hosting the internet model is password protected. A password is provided following completion of a simple registration form. Successful access will be rewarded by sight of the welcome page, **fig 8.1.**

Inputs

Example input and weather files in the correct format for the internet version are downloadable from the website and are distinguished from those operating the PC version by the letter W in the name.

The simplest of the four files is called *test1W.dia* and contains the minimum of information to run the model. It includes a single soil layer, a single crop with no irrigation or fertilization. The model will not run with less data than supplied here. The second file *test2W.dia* is more complex and includes a simple fertilization and irrigation trigger. Three soil layers have been initialized. The third file, *test3W.dia* contains a rotation of two crops but again with only one single fertilisation and irrigation per crop. A fourth example, *complexW.dia* is more complex and includes all the main model triggers in situ for a one season crop. It will run but will take longer to run that the other three.

Outputs

A zip file is returned to the user containing several text files. The text files are most reliably read using Wordpad.   Notepad can read the files but the format can be sloppy.

An excel file utility is downloadable to read and provide principle graphs. graph
A utility is available for
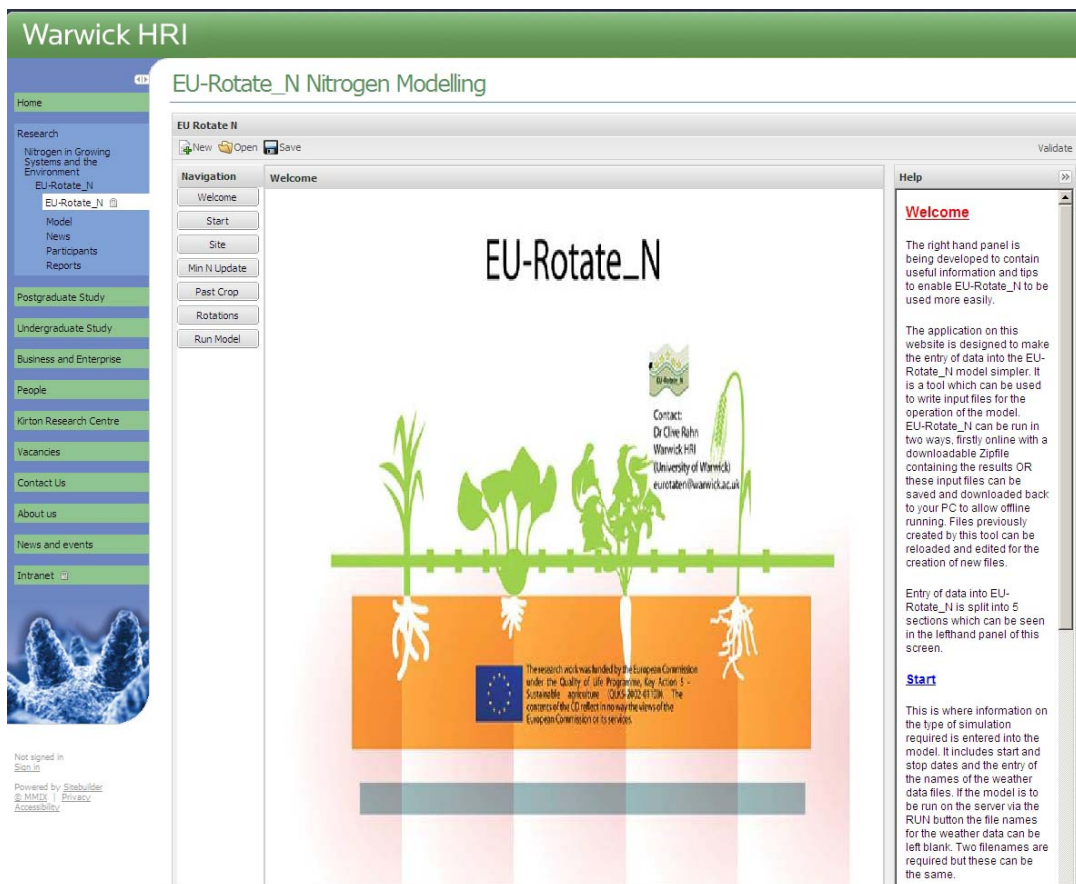
Fig 8.1 The welcome screen of EU-Rotate_N as it sits on the Warwick HRI website. The panel on the right provides help for data entry on each page.

There are SIX main input screens which are based on the inputs for the PC based model **(see section 4 for details).** The six screens are briefly described below.

START

This is where information on the type of simulation required is entered into the model. It includes start and stop dates and the entry of the names of the weather data files. If the model is to be run on the server via the RUN button, the file names for the weather data can be left blank. Two filenames are required but these can be the same.

SITE

This allows the entry of information about the site, its latitude, altitude, and soil properties.
It is at this point that information on the INITIAL CONDITIONS AND SOIL PROPERTIES (**see section 4.5/6**) for each layer can be entered.
DEFAULTS - a number of default values have been included for two example soil types but these need to be checked for your site.

MIN N UPDATE

Whilst the initial levels of soil mineral N were entered in the previous screen, this form allows for updated values to be entered - such as at the beginning of each cropping season. The data is entered for each layer specified previously. (**see section 4.7**)

PAST CROP

Data on the past crop must be added to initialise the model. The amount, type and N content of the previous crops residues allow EU-Rotate_N to estimate its effect. The amount of residue dry weight can be set to a very low amount where no residues were left.(**see section 4.8**)

ROTATIONS

The main body of information for the cropping rotation is added at this point, **see figure 8.2 and section 4.9,13 and 4.14**)

A choice of over 50 different crops is provided. Most of these are conventionally sown or planted cash crops but provision is also made for the under-sowing of fertility building crops.

The information required depends on the crop selected. The minimum amount of data needed is planting date, row width, plant spacing, starting weight, and N content at planting or drilling. Harvesting information is entered in a separate box, for a single harvest add the target dry weight yield of the whole crop. There must be at least one harvest date. If a fertility building crop is selected another box will become available that allows the dates of mowing to be entered. Below the harvest box there is a panel labeled ECONOMICS which allows account to be taken of variable costs, and crop prices for specified marketing criteria. There is enough information in this section to allow the model to run but it will not estimate GROSS MARGIN for the site unless real data is entered.
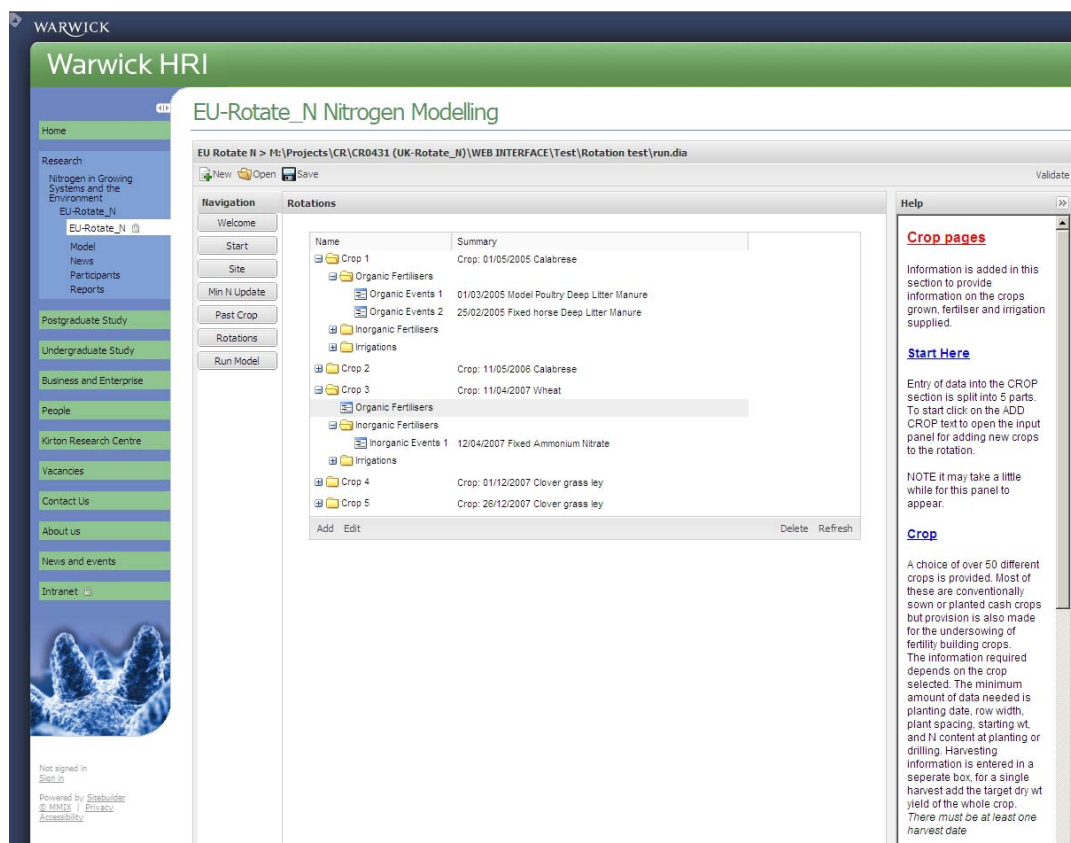
Fig 8.2 Screenshot showing the main input screen for the rotations of crops. It shows how the tree can be expanded to display individual fertilisation and irrigation events.

CROP RESIDUES

Data must be included for each crop grown or the model will not run. The information required includes the date, method and depth of crop residue incorporation. The model estimates the proportion of marketable crop removed but also allows for the amount of N removed if some of the crop residues such as straw are removed from the field. (**see section 4.14**)

ORGANIC FERTILISATION

Information is added here to specify the types and amounts of organic manures that are added. Details include the time of application and the method and date of incorporation. Financial data on the costs of manures and their spreading can be added. (**See section 4.10**)

INORGANIC FERTILISATION

Information is added here to specify the types and amounts of inorganic fertilisers that are added. Details include the time of application and the method and date of incorporation. Financial data on the costs of fertilisers and their spreading can be added. (**see section 4.11**)

IRRIGATION AMOUNTS

Information can be added here for several types of irrigation. Irrigations can be applied in "fixed" amounts or can be calculated on the basis of critical amounts of evapo-transpiration or soil moisture deficit**. (see section 4.12)**

RUN

This is where the model can be run online. To allow this to happen weather data files will need to be specified and uploaded. The results of the simulations will be available for download in a zip file containing a series of output files. The largest contains daily output for a rotation. Software (**See section 2.7**) is provided to interrogate the file which then provides graphs of crop growth and leaching over the rotation as well as summarising the main planting and harvesting dates of each crop.

NOTE Input files for the PC version can be read into the web based version once a couple of lines of text have been modified.

8.2 Differences in format of run files between PC and Web based versions of the model

The following table contains the information needed to allow files made for the PC version to be loaded and run on the internet version of the model. Files made on the internet can be used to run the PC version. The changes between versions are highlighted.

1) Add the word **Inorganic** at the end of the organic fertilisation section (after the incorporation depth) and before the number of inorganic fertiliser events for **each** crop. (If no organic events just insert between organic and inorganic section) – **see below**
2) If the file does not include the line with the output options defined i.e **Brief** or **Detailed** this will need to be added.
3) Make sure that all the text in red is **exactly the same** as in the list below – even slight differences such as incorrect capitalisation or additional letters or words will render the file unreadable in the internet version.
4) Make sure that all the descriptors are in the correct case – For instance **Mix** not **mix**
5) Files made on the internet can be run on the PC version of the model but step 1 will need to be reversed for versions of the model earlier than 1.8.

Test 1W.dia

Site properties

Brief	(String) Output control
52.00	(real) Latitude
45	(real) Altitude
36.5	(real) N deposition (kg/ha)

Simulation period

1994001	(int) Simulation start date (year: julian day, e.g. 1st Jan 1994=1994001)
1994365	(int) Date when simulation ceases (see the above)

Weather file

weather.met	(string) Filename of weather data
2	(int) No of weather data years
weather.met	(String) Filename of the optimisation weather

Switch for winter climate simulation

No	(string) Snow-frost simulation

Soil properties

No	(string) Runoff simulation
9	(real) REW
0.1	(real) Ze
0	(real) maximum rooting depth
30	(int) sampled layer size
1	(int) no of layers sampled
0.31	(real) FC (1st soil layer sampled)
0.11	(real) PWP (1st soil layer sampled)
0.48	(real) SAT (1st soil layer sampled)
1	(real) drainage coefficient (=0.0 if unknown)
0.16	(real) Clay content (1st soil layer sampled)
0.75	(real) Sand content (1st soil layer sampled)
1350	(real) Bulk density (1st soil layer sampled)
6.5	(real) Soil PH (1st soil layer sampled)
0.0178	(real) OM content (1st soil layer sampled)
10	(real) C/N ratio

Initial conditions

0.31	(real) Soil moisture content (1st soil layer sampled)
10	(real) Mineral soil_N kg N/ha (1st soil layer sampled)

Soil mineral N updates

0	(int) number of soil N updates (layers as previous inputs)

Previous crop residue incorporation

1994110	(int) Time of incorporation of previous crop debris
Plough	(string) Method of incorporation
25	(real) Depth of incorporation cm
1000	(real) Residue DM (kg/ha)
26	(int) OM type
0.035	(real) N content

Number of crop in rotation (from fertilisation to residues incorporation)

1	(int) No of crops in rotation

Fertilisation

0	(int) Number of organic fertilisation events
==INORGANIC==	==THIS LINE IS ADDED==
0	(int) Number of inorganic fertilisation events

Irrigation

0	(int) Number of irrigation events

Crop data

8	(int) Crop type from crop table (8=Cauliflower)
60	(real) Row width (cm)
50	(real) Plant spacing
1994141	(int) Planting date

6	(real) Dry weight at planting kg/ha
0	(real) %N in transplant (0.0 if not known)
1	(int) Number of harvests
1994202	(int) Harvest date
5.3	(real) Dry weight of total plant t/ha (target)
0	(real) Weight for DM reduction due to water stress (0.-100.)
600	(real) Marketable min fresh weight per head (g/head)
2000	(real) Marketable max fresh weight per head (g/head)
0.3	(real) CV - variability of marketable product wt.
1500	(real) Price for marketable yield (currency unit/t)
300	(real) Variable costs independent of marketable yield (currency unit/ha)
20	(real) Variable costs dependent on marketable yield (currency unit/t)

Crop residues

1994285	(int) Crop debris incorporation date
Plough	(string) Method of incorporation
25	(int) Depth of incorporation cm
10	(real) Percentage of crop residues removed

APPENDIX 1 – Crop and residue type
For entry into the input file from the crop and residue Tables

Cash crops

1	Broad_beans	2	Brussels_Sprouts
3	Dutch_White_Cabbage	4	Cabbage_Summer
5	Cabbage_Wint/Spring	6	Calabres
7	Carrot	8	Cauliflower
9	Chinese_Cabbage	10	French_beans
11	Leek	12	Lettuce_Butterhead
13	Lettuce_Crisp	14	Maize (grain)
15	Onion	16	Parsnip
17	Peas	18	Potato_Early
19	Potato_Late	20	Radish
21	Red_Beet	22	Spinach
23	Sugar_Beet	24	Swede
25	Turnip	26	Wheat
27	Lamb's_Lettuce	28	Cucumber_for_pickling
29	Kohlrabi	30	Celery
31	Celeriac	32	Small_Radish_(Spring)
33	Small_Radish_(Summer)	34	Kale
35	Tomato	36	Squash
37	Oat	38	Fennel
39	Artichoke	40	Parsley
41	Sweetcorn	42	Oil_Seed_Rape
43	Bell/Sweet_ Pepper	44	Eggplant/Aubergine
45	Water_Melon	46	Radicchio
47	Endive_Curly	48	Endive_Batavian
49	Spring_onion	50	Processing_Tomato
51	Red_cabbage	52	Savoy_cabbage
53	White_cabbage_Industy	54	Barley
55	Rye_and_Triticale	56	Garlic
57	Courgette/Zucchini	58	Cucumber_not_pickling
59	Melon	71	Maize_(corn_cob_mix)
72	Maize_(silage)		

Cover crops

61	Rye_cover	62	Vetch_cover
63	Phacelia_cover	64	Mustard_cover
65	Fodder_raddish_cover	66	Chicory
67	Clover_grass_ley	68	Grass_ley
69	Natural_weeds		

APPENDIX 2 – Target soil mineral N values.

To a specified soil depth and 30cm depth for the KNS trigger extracted from the crop table

No.	CROP	Specified soil depth (cm)	Target soil N value to the specified soil depth (kg/ha)	Target soil N value to 30cm soil depth (kg/ha)
1	Broad_beans	60	110	40
2	Brussels_Sprouts	90	300	40
3	Dutch_White_Cabbage	60	270	40
4	Cabbage_Summer	60	270	40
5	Cabbage_Wint/Spring	60	270	40
6	Calabrese	60	310	80
7	Carrot	60	90	20
8	Cauliflower	60	300	80
9	Chinese_Cabbage	60	210	40
10	French_beans	60	110	40
11	Leek	60	230	40
12	Lettuce_Butterhead	30	150	50
13	Lettuce_Crisp	30	140	50
14	Maize_grain	90	200	60
15	Onion	60	130	20
16	Parsnip	60	100	30
17	Peas	60	100	40
18	Potato_Early	60	100	40
19	Potato_Late	60	160	40
20	Radish	30	140	40
21	Red_Beet	60	230	40
22	Spinach	30	180	40
23	Sugar_Beet	90	200	200
24	Swede	60	100	30
25	Turnip	60	80	30
26	Wheat	90	200	120
27	Lamb's_Lettuce	15	80	40
28	Cucumber_for_pickling	30	190	40
29	Kohlrabi	30	230	60
30	Celery	30	200	40
31	Celeriac	60	200	60
32	Small_Radish_Spring	15	100	40
33	Small_Radish_Summer	15	110	40
34	Kale	60	160	40
35	Tomato	90	160	50
36	Squash	60	200	40
37	Oat	60	130	100

38	Fennel	60	200	60
39	Artichoke	90	200	50
40	Parsley	60	140	20
41	Sweetcorn	90	160	40
42	Oil_Seed_Rape	60	340	120
43	Bell/Sweet_Pepper	60	150	40
44	Eggplant/Aubergine	60	270	60
45	Water_Melon	60	200	50
46	Radicchio	60	140	50
47	Endive_Curly	60	150	50
48	Endive_Batavian	60	190	50
49	Spring_onion	60	190	20
50	Processing_Tomato	90	160	40
51	Red_cabbage	60	220	40
52	Savoy_cabbage	60	250	40
53	White_cabbage_Industy	90	340	40
54	Barley	90	200	120
55	Rye_and_Triticale	90	200	120
58	Cucumber_not_pickling	30	190	40
59	Melon	60	200	50

APPENDIX 3 Model Example File – test1.dia

Do not append or alter the lines in Red or the model will fail . This is the very simplest input file that can be used to run the model – it contains a single crop with no irrigation or fertiliser events.

Site properties
Brief	(String) Output control
52.00	(real) Latitude
45	(real) Altitude
36.5	(real) N deposition (kg/ha)

Simulation period
1994001	(int) Simulation start date (year:julian day, e.g. 1st Jan 1994=1994001)
1994365	(int) Date when simulation ceases (see the above)

Weather file
weather.met	(string) Filename of weather data
2	(int) No of weather data years
weather.met	(String) Filename of the optimisation weather

Switch for winter climate simulation
No	(string) Snow-frost simulation

Soil properties
No	(string) Runoff simulation
9	(real) REW
0.1	(real) Ze
0	(real) maximum rooting depth
30	(int) sampled layer size
1	(int) no of layers sampled
0.31	(real) FC (1st soil layer sampled)
0.11	(real) PWP (1st soil layer sampled)
0.48	(real) SAT (1st soil layer sampled)
1	(real) drainage coefficient (=0.0 if unknown)
0.16	(real) Clay content (1st soil layer sampled)
0.75	(real) Sand content (1st soil layer sampled)
1350	(real) Bulk density (1st soil layer sampled)
6.5	(real) Soil PH (1st soil layer sampled)
0.0178	(real) OM content (1st soil layer sampled)
10	(real) C/N ratio

Initial conditions
0.31	(real) Soil moisture content (1st soil layer sampled)
10	(real) Mineral soil_N kg N/ha (1st soil layer sampled)

Soil mineral N updates
0	(int) number of soil N updates (layers as previous inputs)

Previous crop residue incorporation
1994110	(int) Time of incorporation of previous crop debris
Plough	(string) Method of incorporation
25	(real) Depth of incorporation cm
1000	(real) Residue DM (kg/ha)
26	(int) OM type
0.035	(real) N content

Number of crop in rotation (from fertilisation to residues incorporation)

1	(int) No of crops in rotation

Fertilisation

0	**(int) Number of organic fertilisation events**
0	**(int) Number of inorganic fertilisation events**

Irrigation

0	**(int) Number of irrigation events**

Crop data

8	(int) Crop type from crop table (8=Cauliflower)
60	(real) Row width (cm)
50	(real) Plant spacing
1994141	(int) Planting date
6	(real) Dry weight at planting kg/ha
0	(real) %N in transplant (0.0 if not known)
1	(int) Number of harvests
1994202	(int) Harvest date
5.3	(real) Dry weight of total plant t/ha (target)
0	(real) Weight for DM reduction due to water stress (0.-100.)
600	(real) Marketable min fresh weight per head (g/head)
2000	(real) Marketable max fresh weight per head (g/head)
0.3	(real) CV - variability of marketable product wt.
1500	(real) Price for marketable yield (currency unit/t)
300	(real) Variable costs independent of marketable yield (currency unit/ha)
20	(real) Variable costs dependent on marketable yield (currency unit/t)

Crop residue

1994285	(int) Crop debris incorporation date
Plough	(string) Method of incorporation
25	(int) Depth of incorporation cm
10	(real) Percentage of crop residues removed

APPENDIX 4 Model Example File – Complex.dia

**Do not append or alter the lines in Red or the model will fail.   This is an example of
a more complex input file containing several triggers for organic, inorganic and
irrigation events.**

Site properties

Brief	(string) Output control
60.77	(real) Latitude
127	(real) Altitude
36.5	(real) N deposition (kg/ha)

Simulation period

1994001	(int) Simulation start date (year:julian day, e.g. 1st Jan 1994=1994001)
1994365	(int) Date when simulation ceases (see the above)

Weather file

weather.met	(string) Filename of weather data
2	(int) No of weather data years
weather.met	(String) Filename of the optimisation weather

Switch for winter climate simulation

No	(string) Snow-frost simulation

Soil properties

No	(string) Runoff simulation
9	(real) REW
0.1	(real) Ze
0	(real) maximum rooting depth
30	(int) sampled layer size
3	(int) no of layers sampled
0.29	(real) FC (1st soil layer sampled)
0.11	(real) PWP (1st soil layer sampled)
0.48	(real) SAT (1st soil layer sampled)
0	(real) drainage coefficient (=0.0 if unknown)
0.23	(real) FC (2nd soil layer sampled)
0.09	(real) PWP (2nd soil layer sampled)
0.4	(real) SAT (2nd soil layer sampled)
0	(real) drainage coefficient (=0.0 if unknown)
0.19	(real) FC (3rd soil layer sampled)
0.08	(real) PWP (3rd soil layer sampled)
0.33	(real) SAT (3rd soil layer sampled)
0	(real) drainage coefficient (=0.0 if unknown)
0.19	(real) Clay content (1st soil layer sampled)
0.37	(real) Sand content (1st soil layer sampled)
1350	(real) Bulk density (1st soil layer sampled)
6.5	(real) Soil PH (1st soil layer sampled)
0.04	(real) OM content (1st soil layer sampled)
0.16	(real) Clay content (2nd soil layer sampled)
0.38	(real) Sand content (2nd soil layer sampled)
1580	(real) Bulk density (2nd soil layer sampled)
6.5	(real) Soil PH (2nd soil layer sampled)
0.015	(real) OM content (2nd soil layer sampled)
0.14	(real) Clay content (3rd soil layer sampled)

0.47	(real) Sand content (3rd soil layer sampled)
1760	(real) Bulk density (3rd soil layer sampled)
6.5	(real) Soil PH (3rd soil layer sampled)
0.009	(real) OM content (3rd soil layer sampled)
10	(real) C/N ratio

Initial conditions

0.29	(real) Soil moisture content (1st soil layer sampled)
0.23	(real) Soil moisture content (2nd soil layer sampled)
0.19	(real) Soil moisture content (3rd soil layer sampled)
10	(real) Mineral soil_N kg N/ha (1st soil layer sampled)
5	(real) Mineral soil_N kg N/ha (2nd soil layer sampled)
5	(real) Mineral soil_N kg N/ha (3rd soil layer sampled)

Soil mineral N updates

1	(int) number of soil N updates (layers as previous inputs)
1994002	(int) date of soil N Update
50	(real) Mineral soil_N kg N/ha (1st soil layer sampled)
50	(real) Mineral soil_N kg N/ha (2nd soil layer sampled)
50	(real) Mineral soil_N kg N/ha (3rd soil layer sampled)

Previous crop residue incorporation

1994110	(int) Time of incorporation of previous crop debris
Plough	(string) Method of incorporation
25	(real) Depth of incorporation cm
5000	(real) Residue DM (kg/ha)
26	(int) OM type
0.035	(real) N content

Number of crop in rotation (from fertilisation to residues incorporation)

1	(int) No of crops in rotation

Fertilisation

1	**(int) Number of organic fertilisation events**
Fixed	(String) Event type (Fixed)
1994118	(int) Fertilisation date
1000	(real) Amount of fresh weight to apply (kg/ha)
10	(int) Organic fertiliser type (from organic fertilisers table)
1	(real) Cost of fertiliser (currency unit/kg)
10	(real) Cost of applying fertiliser (currency unit/ha)
Plough	(String) Incorporation Method
1	(int) Incorporation delay (number of days after fertilisation)
30	(real) Incorporation depth (cm)
3	**(int) Number of inorganic fertilisation events**
Fixed	(String) Event type (Fixed, Target)
1994134	(int) Fertilisation Date
5	(real) Amount of fertiliser to apply (kg/ha)
1	(int) Inorganic fertiliser type (from inorganic fertilisers table)
1	(real) Cost of fertiliser (currency unit/kg)
10	(real) Cost of applying fertiliser (currency unit/ha)
Mix	(String) Incorporation Method
2	(int) Incorporation delay (number of days after fertilisation)
30	(real) Incorporation depth (cm)
Target	(String) Event type (Fixed, KNS or Target)
1994135	(int) Inorganic fertiliser trigger enable date
1994136	(int) Inorganic fertiliser trigger disable date
1	(int) Inorganic fertiliser type (from inorganic fertilisers table)

1	(real) Cost of fertiliser (currency unit/kg)
10	(real) Cost of applying fertiliser (currency unit/ha)
10	(real) Minimum fertiliser amount
100	(real) Maximum fertiliser amount
0	(int) Delay (in days) before top dressing (if necessary)
Plough	(String) Incorporation Method
0	(int) Incorporation delay (number of days after fertilisation)
30	(real) Incorporation depth (cm)
KNS	(String) Event type (Fixed, KNS or Target)
1994181	(int) Inorganic fertiliser trigger enable date
1994240	(int) Inorganic fertiliser trigger disable date
1	(int) Inorganic fertiliser type (from inorganic fertilisers table)
1	(real) Cost of fertiliser (currency unit/kg)
10	(real) Cost of applying fertiliser (currency unit/ha)
10	(real) Minimum fertiliser amount
100	(real) Maximum fertiliser amount
5	(int) Number of days that trigger is disabled after fertilisation
Mix	(String) Incorporation Method
0	(int) Incorporation delay (number of days after fertilisation)
30	(real) Incorporation depth (cm)

Irrigation

3	**(int) Number of irrigation events**
Fixed	(String) Event type (Fixed, Content or Evapo)
1994010	(int) Irrigation date
Sprinkler	(String) Irrigation method
1	(real) Fraction of wetted soil surface
25	(real) Amount (mm)
0.0001	(real) N conc in irrigation water (g/l)
Evapo	(String) Event type (Fixed, Content or Evapo)
1994010	(int) Evapo trigger enable date
1994180	(int) Evapo trigger disable date
Sprinkler	(String) Irrigation method
1	(real) Fraction of wetted soil surface
25	(real) Amount (mm)
0.0001	(real) N conc in irrigation water (g/l)
50	(real) Trigger evaporation sum threshold (mm)
Content	(String) Event type (Fixed, Content or Evapo)
1994181	(int) Content Trigger enable date
1994240	(int) Content Trigger disable date
Sprinkler	(String) Irrigation method
1	(real) Fraction of wetted soil surface (0-1)
25	(real) Amount (mm)
0	(real) N conc in irrigation water (g/l)
50	(real) Trigger critical deficit (mm)
100	(real) Lower Boundary depth for deficit (cm)

Crop data

26	(int) Crop type from crop table (26=Wheat)
13	(real) Row width (cm)
2	(real) Plant spacing
1994121	(int) Planting date
170	(real) Dry weight at planting kg/ha
2	(real) %N in transplant (0.0 if not known)

1	(int) Number of harvests
1994244	(int) Harvest date
9.35	(real) Dry weight of total plant t/ha (target)
0	(real) Weight for DM reduction due to water stress (0.-100.)
0	(real) Marketable min fresh weight per head (g/head)
0	(real) Marketable max fresh weight per head (g/head)
0	(real) CV - variability of marketable product wt.
150	(real) Price for marketable yield (currency unit/t)
300	(real) Variable costs independent of marketable yield (currency unit/ha)
20	(real) Variable costs dependent on marketable yield (currency unit/t)

Crop residues

1994285	(int) Crop debris incorporation date
Plough	(string) Method of incorporation
25	(int) Depth of incorporation cm
10	(real) Percentage of crop residues removed