Ce fichier comprend deux parties:

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* La Foire aux questions / Frequently asked questions (p. 47)

**Save trees – do not print!**

PARTIE I  
Comment utiliser FlorSys   
*How to run FlorSys?*

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(Updated sections are marked with date of their last update)

# Prologue

24/07/2018

FlorSys est une plateforme expérimentale virtuelle où l'on peut tester de nombreux et divers systèmes de culture à long terme et avec différentes flores adventices, conditions météo et types de sol. Le modèle a comme objectif de comparer des systèmes de culture plutôt que de prédire des valeurs absolues dans une condition donnée (voir exemples, section 10.4). FlorSys ne peut pas "copier" un champ donné et prédire les mêmes valeurs absolue exactes (par ex. densité adventice au jour J) parce que trop de variables et paramètres sont mal connus, particulièrement le stock semencier initial. Ceci n'est cependant pas en cause la capacité du modèle à classer correctement les situations.

De toute manière, il s'agit d'un modèle (càd, une simplification de la réalité) développé pour un objectif donné (càd, comparer des systèmes de culture) et ne doit pas être confondu avec la réalité; les utilisateurs devraient toujours être conscients des limites du modèle. Et contrairement à beaucoup de modèles (notamment les modèles de dynamique adventice), FlorSys a été évalué avec des observations de terrain indépendantes, ce qui nous a permis de déterminer son domaine de validité, les erreurs de prédiction et les processus manquants (section 10.3).

Du point de vue sortie, il faut privilégier les sorties synthétiques (indicators.prn) qui traduisent les nombreuses variables en impact des adventices sur la production agricole et la biodiversité. Les sorties détaillées sur la flore sont plus difficiles à interpréter et leur niveau de détail peut parfois induire en erreur par rapport au terrain. Par ex, le modèle quantifie des plantules au stade levée (stade cotylédon) qui, sur le terrain, passent souvent inaperçues à cause de leur taille mais aussi parce qu'une bonne partie meurt avant d'atteindre le stade plantule. De plus, les sorties détaillées dépendent du pool d'adventices initial souvent mal connu.

NB: tous les fichiers sont des fichiers texte

* Tous les fichiers d'entrée (\*.dat) sont décrits en détail dans InputFLORRSYS.xlsx
* Les paramètres du cycle de vie (\*.par) sont décrits dans ParametersSpeciesFLORSYS.xlsx, les paramètres de l'impact de la flore adventice dans ParametersIndicatorsFLORSYS.xlsx, les paramètres nécessaires pour l'effet des herbicides dans HerbicideFileDescription.xlsx,
* Tous les fichiers de sortie (\*.prn) sont décrits dans OutputFLORSYS.xlsx

Des informations supplémentaires se trouvent dans FAQ.doc.

*FlorSys is a virtual experimental platform where many and contrasting cropping systems can be tested in the long term and with different weed floras, weather conditions and soil types. It aims to compare cropping systems rather than to predict absolute values in a given condition (see examples in section 10.4). It cannot "copy" a given farmer's field and predict the exact same absolute values (e.g. weed density on day D) because too many variables and parameters are insufficiently known, particularly the exact initial weed seed back. This does though not preclude the model from correctly ranking situations.*

*In any case, it is a model (i.e. a simplification of reality) developed for a specific aim (i.e. to compare cropping systems) and should not be confused with reality, meaning that the user should always be conscious of the model's limits. In contrast with many other models (particularly weed dynamics models), FlorSys was evaluated with independent field observations, which allowed us to determine its domain of validity, prediction error and missing processes (section 10.3).*

*In terms of output, synthetic outputs (indicators.prn) should be preferred as they translate the many stage variables into weed impacts on crop production and biodiversity. The detailed weed output variables are more difficult to interpret and their level of detail can sometimes lead to erroneous conclusions compared to field observations. For instance,* FlorSys *quantifies seedling at emergence (cotyledon stage) which, in fields, are often missed by assessors because of their smallness, but also because a large part of them dies before reaching the next stage.*

*NB: All files are text files.*

* *all input files (\*.dat) are described in detail InputFLORSYS.xlsx.*
* *life-cycle parameters files (\*.par) are described in detail in ParametersSpeciesFLORSYS.xlsx, weed-impact parameters in ParametersIndicatorsFLORSYS.xlsx, herbicide parameter files in HerbicideFileDescription.xlsx,*
* *all output files (\*.prn) are described in detail in OutputFLORSYS.xlsx*

*Additional information can be found in FAQ.doc.*

# How to install FlorSys?

## The zipped directory

You will receive FlorSys as directory (usually zipped), comprising the Florsys.exe file, the florsys.dat input file, and the following subdirectories:

* Fields
* Parameters
* Climate

Unzip the directory, respecting the paths of the subdirectories.

## The exe file

The exe file is named as FlorsysDDMMYYYY.exe, with DDMMYYYY the version.

## The subdirectories

|  |  |  |  |
| --- | --- | --- | --- |
| Directory name | Type of content | Subdirectories | Type of content |
| Fields | Virtual fields (simulation directories) that have or will be simulated (section 7) | Biblio\_Simul | Ten subdirectories corresponding to 10 virtual fields provided as examples. These 10 fields correspond to the cropping-system trial run since 1999 at the INRA experimental station at Dijon-Epoisses ([Chikowo *et al.*, 2009](#_ENREF_3)) |
| DefaultField | Default input files which are read if obligatory input files are missing in the virtual-field chosen for simulation |
| XXXX | New virtual-field directory created by user (section 3) |
| YYYY | New virtual-field directory created by user |
| … |  |
| Parameters | Model parameters | Herbicides | List of herbicide brands and their efficiencies (section 5.2) |
| Species | Crop and weed species parameters (section 4.3) |
| Tillage | Parameters for seed movements during tillage (section 5.1) |
| MiniSticsC | Parameters for STICS submodel for prediction soil hydrothermal variables (section 5.4) |
| Climate | Files with climate variables | Climate | Weather files with records from weather stations (section 6.1) |
| Soil | Files with soil hydrothermal variables (section 6.2) |

## What to do when receiving a FlorSys update?

You will regularly receive updates, where bugs reported by users were corrected and/or new submodels (e.g. weed-impact indicators) were added.

* Unzip the zipped file into a new directory
* Transfer you virtual fields into the new Fields subdirectory (section 3)
* Transfer any personal weather files into the new Climate subdirectory (section 6)
* If you modified herbicidsPERSO.par and reference\_herbicides.par, transfer them from the old Parameters/Herbicides subdirectory into the new one (section 5.2), after checking that the file format has not been changed in the new FlorSys version
* If you modified the nominal species-parameter files in Parameters/Species, transfer them to the new Parameters/Species directory (section 4.3), after checking that the file format has not been changed in the new FlorSys version

# Prepare a virtual field

## Where to put the input files?

Input files describing the cropping system and the soil of the virtual field are put into a simulation directory. You can put this directory anywhere on your computer, but best put it into the Fields subdirectory of the FlorSys main directory.

## Which files are necessary?

Updated 06/05/2024

See *OrganizationFLORSYS (1 plot)* in *InputFLORSYS.xlsx*

## File content

The content of these files is described in InputFLORSYS.xlsx.

**Caution decimals as xxx.xx et not as xxx,xx (use a point not a comma)**

## Summary of the necessary input variables

See also FAQ.doc

### Initial seed bank

06/05/2024

Measured seed banks are usually not available for initializing simulations, and are, moreover, not necessarily better than initial seed banks based on regional flora observations ([Colbach *et al.*, 2016](#_ENREF_16)). We thus developed a method to constitute a potential regional seed bank from weed flora observations (section 4.2.1). The following data are needed:

* Weed plant density (in plants/m² if possible, Barralis or other class-based assessement otherwise) before herbicide treatment if possible
* In the crops most frequent in the region
* Over several years.

A large collection of seed banks (and the corresponding seedImmigration.dat files) typical of different French regions is available in DataBase/Seedbanks. An R script to create such seed bank from field observations is also provided.

### Cropping system

30/11/2019 updated 30/06/2022

Details on cropping system variables are given in the *ITK.dat (CroppingSystem)* sheet of InputFLORSYS.xlsx. See also FAQ.doc

In bold: variables with an important effect. All variables are necessary but default values can be used for less important variables.

|  |  |
| --- | --- |
| Crop | **All crops, including catch crops, undersown crops, associated crops**. To find the closest FlorSys proxy for a crop that is not yet parameterized in FlorSys, see *Crops* sheet in InputFLORSYS.xlsx |
| Crop variety | To find the closest FlorSys proxy for a variety that is not yet parameterized in FlorSys, see *CropVarieties* sheet in InputFLORSYS.xlsx |
|  |  |
|  | For each operation |
| Tillage | **Date**, **tool**, **depth**, tractor speed (if possible)  (if possible) Skim-coulter depth and width in case of mouldboard ploughing  To find the closest FlorSys proxy for a tillage tool, see section 13.7.1 |
| Sowing | **Date, density, interrow width** (**or broadcast**), **sowing depth** (approximate), orientation of crop rows (north-south or east-west), crop seed lot contamination by weed seeds |
| Herbicides | **Date, commercial product or active ingredient, rate, spraying pattern** (whole field, only rows, only interrows), conditions (always in optimal temperature and moisture conditions, medium, bad)  Also see section 5.2 |
| Mechanical weeding | **Date, tool**, **depth (**approximate**)**, tractor speed (if possible)  Pattern: **whole field, only interrows** (weeding width)  To find the closest FlorSys proxy for a tillage tool, see section 3.6 in FAQ.doc |
| Mineral nitrogen | **Date, rate**, type (i.e. % of NH4 in fertilizer) |
| Organic fertilizer (manure…) | **Date, amount** (ton fresh matter) per ha, **type** (bovine manure, …)  **Mineral nitrogen content** (kg N per ton fresh matter)  Seed content per ton or m³ for each weed species |
| Mulch | **Date,**  **crop species, amount** (ton fresh matter) per ha |
| Mowing | **Date, cutting height** (approximate), **is biomass exported or not** |
| Shredding (*broyage*) during fallow | **Date** *(Shredding cuts all plants at soil surface without disturbing soil or seeds)* |
| Topping (*écimage*) during crop growth | **Date** *(Topping cuts all weed plants taller than the tallest crop plant at the height of the tallest crop plant)* |
| Harvest operations | **Date, cutting height** (approximate), crop seed loss if volunteers are to be simulated |
| Irrigation | **Date, amount** |

If some information is missing, take default values from DefaultValuesCroppingSystem.xlsx.

### Weather

06/05/2024

Daily

ETP, radiation, precipitation, mean, minimum and maximum temperatures

See section 6.

See the *Weather* sheet in InputFLORSYS.xlsx. See also FAQ.doc

**FlorSys comes with a large data base of weather files, see DataBase/Climate.**

### Soil characteristics

06/05/2024

See the *sol.dat* sheet in InputFLORSYS.xlsx. See also FAQ.doc

**FlorSys comes with a large data base of soil files, see DataBase/Soils.**

#### General variables

|  |  |
| --- | --- |
| Soil texture | % clay, sand etc |
|  | % gravel or stones |
| Soil depth | cm |

#### STICS input variables for soil

FlorSys includes the STICS submodel for hydrothermal conditions and thus requires the corresponding STICS inputs (Appendix 1).

Advice. Ask around whether anyone ran STICS simulation on your soil or a similar soil and get the parameter file.

# Choose and describe the species to simulate

## Choose the species to simulate

Updated 17/07/2017

The list of weed and crop species to be simulated in the virtual field must be listed in species.dat. This file can be located in the virtual-field directory. If missing, it will be read in Fields/DefaultField.

All species listed in species.dat must have all their life-cycle parameters estimated. If the crop species that you want to simulate is missing in FlorSys, you can choose a similar species by adding your species to the SpeciesEquivalency.par file (section 4.4.4).

You can list more species than are actually used in the simulation (e.g. list all species that are entirely parameterized in FLORSYS, section 4.3)

## How to introduce weeds into the simulation

### The initial seed bank (necessary)

12/03/2020

The initial seed bank file (name given in configFile.dat) located in the virtual-field directory lists the seeds of each weed species present on the first day of the simulation. If you want to run a weed-free simulation, create a seed bank file without any seeds. You can also use final seed banks (seedBankFinal.prn, section 8) left at the end of previous simulations.

All the species listed in this file must also be listed in species.dat (section 4.1).

As users rarely know the seed bank of their fields, we developed a method to estimate a probable initial seed bank from regional flora measurements ([Colbach *et al.*, 2016](#_ENREF_16)). createInitialSeedBankFile.R in the R\_scrips subdirectories allows to create this file automatically (as well as for seed immigration, section 4.2.2) from a file comprising average weed densities (Figure 1). Regional flora observations are better than using observations from individual fields as they have a lower risk of missing rare species and are closer to the regional flora potential.

Figure 1. Example of file comprising data of average weed plants densities used to calculate initial seed bank and seed-immigration files with createInitialSeedBankFile.R

Species MeanDensity

CAPBP 29.54

CHEAL 19.78

GALAP 3.38

MATIN 12.12

POAAN 61.1

POLAV 18.1

POLCO 23.28

POLLA 2.54

POLPE 5

SENVU 1.1

SONAS 0.6

STEME 41.52

VERPE 10.38

VIOAR 49.38

### Seed immigration (optional)

12/03/2020

Each year, a small number of seeds immigrates into the field, due to natural vectors and agricultural machinery. This immigration is described in the seedImmigration.dat file. If this file is missing, no seed immigration is simulation.

All the species listed in this file must also be listed in species.dat (section 4.1).

As data about seed immigration is not available, we developed a method to estimate probable seed migration values from regional flora measurements ([Colbach *et al.*, 2016](#_ENREF_16)). createInitialSeedBankFile.R in the R\_scrips subdirectories allows to create the seed immigration file automatically (as well as for the initial seed bank, section 4.2.1) from a file comprising average weed densities (Figure 1). Regional flora observations are better than using observations from individual fields as they have a lower risk of missing rare species and are closer to the regional flora potential.

### Manure

06/11/2016

Weed seeds can also enter a field when manure contaminated with weed seeds is applied. The weed-seed content of manure is described in a separate file (see manure.dat sheet in InputFLORSYS.xlsx). Examples of weed seeds in manure can be found in ([Colbach *et al.*, 2013b](#_ENREF_12)).

All the species listed in this file must also be listed in species.dat (section 4.1).

### Sown crop seed lots

06/11/2016

Weed seeds can also enter a field when sown crop seed lots are contaminated with weed seeds. The weed-seed content of crop seed lots is described in a separate file (see copSeedLotContamination sheet in InputFLORSYS.xlsx).

All the species listed in this file must also be listed in species.dat (section 4.1).

## Species parameters

Updated 17/07/2017

Species-parameter files (\*.par) can be located in the virtual-field directory. If they are not located there, the files from Parameters/Species are used.

The following species-parameter files are used by FlorSys:

|  |  |  |
| --- | --- | --- |
| **File name** | **Parameters for** | **Required for simulation?** |
| **Life-cycle parameters** |  |  |
| growth\_parameters.par | Plasticity and growth | Required |
| morphological\_parameters.par | All other post-emergence processes | Required |
| seed\_bank\_parameters.par | Pre-emergence processes | Only some parameters are indispensable (see details in ParametersFLORSYS.xlsx) |
| Fitness.par | Seed production of herbicide-resistant populations | If missing, no variation in seed production (only for herbicide resistance submodel) |
| Mutation.par | Mutation rates | If missing, no mutation (only for herbicide resistance submodel) |
| SpeciesEquivalency.par | Proxies for missing crop species | Required if crop species other than those listed in species.dat (section 4.1) are to be simulated |
|  |  |  |
| **Weed-impact indicators** |  |  |
| EllenbergN.par | Calculating indicator of weed contribution to reducing nitrogen leaching | Missing weed species do not contribute to indicator |
| NuisibiliteTriageBiomNonGraines.par | Calculating indicator of harvest contamination by weed biomass (per crop species) | Missing weed or crop species do not contribute to indicator |
| NuisibiliteTriageGraines.par | Calculating indicator of harvest contamination by weed seeds (per crop species) | Missing weed or crop species do not contribute to indicator |
| PhelipancheCrop.par | (work in progress) |  |
| PhelipancheWeed.par | (work in progress) |  |
| PouvoirCalorifique.par | Energy of crop harvests | Missing weed species do not contribute to indicator |
| RegimeOiseaux.par | Calculating indicator of weed seed offer for birds | Missing weed species do not contribute to indicator |
| RegimesCarabes.par | Calculating indicator of weed seed offer for carabids | Missing weed species do not contribute to indicator |
| ValeurPollinique.par | Calculating indicator of weed flower offer for pollinisateurs | Missing weed species do not contribute to indicator |

The file content of life-cycle parameters is described in ParametersSpeciesFLORSYS.xlsx, weed-impact parameter files are described in ParametersIndicatorsFLORSYS.xlsx.

## How to modify or add new species

09/11/2020

Also read section 12 – Parameterization in FLORSYScontent.docx

### Create new species-parameter files

If you want to modify species parameters, copy the relevant species-parameter file from Parameters/Species to your virtual-field subdirectory and modify the parameter values in this new file. The modifications will only apply to this virtual field. If you want to apply these modifications to other virtual fields, you must copy the modified species-parameter file to the corresponding virtual-field directories.

If you want to add new species, follow the same procedure.

### Modify the nominal species-parameter files

You can theoretically modify the values of the species-parameter files in the Parameters/Species directory or add new species to these files. In that case, keep a backup of the original file in a safe location in case you want to go back to the original parameter values.

If you want the new species to be included into the official FlorSys version, contact [Nathalie.Colbach@inrae.fr](mailto:Nathalie.Colbach@inrae.fr).

### When adding a new species do not forget to…

When adding a new species, in addition to add the species parameters to the \*.par files, do not forget

* To add the species to species.dat (section 4.1),
* To add the species to the FlorSys-STICS correspondence file MatchSpecies.par (section 5.4.3)

### Choose a similar proxy for your crop species

17/07/2017

If the crop species that you want to simulate in not included in species.dat (section 4.1) and no similar crop species in proposed in SpeciesEquivalency.par (section 4.3), then you can propose a proxy among the species listed in species.dat and add it to SpeciesEquivalency.par. If you modify the SpeciesEquivalency.par in the Parameters/Species directory, your choice will apply to all future simulations run with FlorSys. If you copy SpeciesEquivalency.par to the simulation subdirectory and amend this new version, your choice will only apply to this simulation.

### Where to find the parameters for a new species

08/12/2017

parametersSpeciesFLORSYS.xlsx comprises a sheet listing all necessary species parameters and how to measure or find values for them. The latest FlorSys version (08122017 and later versions) are now able to estimate not only pre-emergent but also several post-emergent parameters from species traits. The latter parameters comprise early growth parameters as well as parameters describing potential plant morphology and shading response.

# Parameters for cropping system effects

## Tillage

Tillage and mechanical tools parameterized in FlorSys are described in the file FAQ.docx.

### Location

The tillage-parameter files are located in Parameters/Tillage.

### Files

The parameter files comprise proportions of seeds moving between soil layers for different tillage tools

|  |  |  |
| --- | --- | --- |
| **File name** | **Parameters for** | **Required for simulation?** |
| Bechage.par | Spading | yes |
| Chisel.par | Chisel plough | yes |
| Hrot.par | Power harrow | yes |
| Melange5.par | Uniformly mixing 5-cm deep tillage | yes |
| Melange10.par | Uniformly mixing 10-cm deep tillage | yes |
| Rota.par | Rotavator | yes |
| Rouleau.par | Roll | yes |
| Vibro.par | Spring tine | yes |
| \*.pX | Mouldboard ploughing | Created by FlorSys |

### What to do with these files?

Nothing! Do not modify.

## Herbicides

08/12/2015

FlorSys recognizes only names of commercial products (not the names of the active ingredients).

### Location

The herbicide-parameter files are located in Parameters/Herbicides.

### Files

13/03/2019

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| File Name |  | Source | Required for simulation? | How to use? |
| herbicidesACTA.par | fixed | § | yes | Do not modify |
| herbicidesARVALIS.par | fixed | $ | Optional (only available for INRA staff) | Do not modify |
| herbicidesFLORSYS.par | fixed | # | optional | Do not modify |
| herbicidesRESISTANCE.par | fixed | % | optional | Only necessary for running simulations with herbicide resistance |
| herbicidesPERSO.par | fixed | User | optional | To add new herbicides |
| reference\_herbicides.par | fixed |  | yes | To add new herbicides |
| ALSherbicides.par | fixed |  | optional | Only necessary if ALS resistance is simulated |

§ ([Mamarot & Rodriguez, 2003](#_ENREF_30))

$ ARVALIS Institut du Végétal, extracted from DECID'HERB ([Munier-Jolain *et al.*, 2005](#_ENREF_34))

# Data added by FlorSys team for herbicide-sensitive species populations from expertise and literature

% Literature (work in progress)

Reference\_herbicides.par lists equivalencies between commercial products corresponding to a given active ingredient, choosing one brand as reference. This reference brand name will be used in error and warning messages (section 7.4). The herbicideXXXX.par files list entry modes, persistence and efficiencies of the reference brands for a given application rate and the target weed species. If a weed species (or the corresponding botanical family or taxa) is not listed for a given brand, the latter will have no effect on this species. If the simulated herbicide is not listed in reference\_herbicides.par, a zero efficiency is simulated.

If a reference brand is listed with the same application rate and target weed in several herbicidesXXXX.par files, the following priority applies: herbicidesRESISTANCE.par > herbicidesPERSO.par > herbicidesFLORSYS.par > herbicidesARVALIS.par > herbicidesACTA.par, i.e. the information listed in herbicidesRESISTANCE.par takes precedence over any other files, the information of herbicidesACTA.par is only used if none is available in any of the other files.

ALSherbicides.par lists ALS herbicide products.

If files with the same names are placed into the virtual-field directory, they take precedence over the default files in the Parameters/Herbicides directory.

File content is described in detail in HerbicideFileDescription.xlsx.

### How to add a new herbicide?

29/08/2015

If you want to simulate the effect of a herbicide not yet listed in the herbicide-parameter files,:

* if the active ingredient is already listed, you must add the brand name to reference\_herbicides.par,
* if the active ingredient is not yet listed, you must
  + add the brand name as a new reference brand with the corresponding active ingredient in reference\_herbicides.par,
  + add the entry modes, persistence and efficiencies of the reference brands for a given application rate and the target weed species in herbicidesPERSO.par.

You might also want to add mixtures of existing herbicide brands. The easiest way to handle mixture is to list them individually in the cropping system file (section 3), using the same spraying date for all products. However, because of stochasticity in herbicide penetration into the crop canopy and in weed detection (notably during patch spraying), this can mean that a given weed plant is affected by one product but not the next one. If you want to ensure that all herbicides of a mixture reach a given plant, add the mixture as new herbicide to herbicidesPERSO.par.

### What if the herbicide required in the cropping system file is not listed?

08/12/2015

If the herbicide required in the cropping system file is not listed is not listed in reference\_herbicides.par, no effect is simulated by FlorSys. The same applies if the reference brand given in reference\_herbicides.par for the required herbicides is not listed in any herbicideXXXX.par file,

### What if the required herbicide rate is not listed?

If the application rate you want to simulate with your cropping-system file (section 1) is not listed in any herbicideXXXX.par file for your target weed, FlorSys automatically estimates the associated efficiency from efficiencies listed for other application rates of the same brand and target weed. You can also add the missing brand x rate x target weed information to herbicidesPERSO.par.

### What if a weed species is not listed for a given herbicide?

If a weed species is not listed for a given reference brand at any application rate, FlorSys checks whether information is available for the botanical family (e.g. VERXX for VERHE) or the taxa (e.g. dicotyledonous species for VERHE) and then uses this information. If none of this information is available, a zero efficiency is assumed.

If you want the herbicide to have an effect, you must add it (section 5.2.3).

### How to avoid killing a crop species by a herbicide?

14/10/2016

The only herbicides targeting crop species are those listing ALL as target species in the herbicides.par files. Two options to destroy a crop species with a non-selective herbicide (e.g. glyphosate):

* Replace the ALL option by the targeted weed species, with one line per weed species,
* Add the herbicide in HerbicidesPERSO.par, indicating the crop species as target species, and specify a zero mortality. This takes precedence over the general ALL instruction.

## Other Pesticides

09/11/2020

FlorSys also accepts fungicides, insecticides, growth regulators etc. These do not have any effect on crops or weeds at the moment. However, they contribute to the weed-impact indicator assessing how far weeds reduce pesticide transfer to ground and surface water ([Queyrel & Colbach, 2016a](#_ENREF_38); [Queyrel & Colbach, 2016b](#_ENREF_39)).

## STICS submodel predicting soil hydrothermal variables

### Location

The parameter files for running the STICS submodel predicting soil hydrothermal variables are located in Parameters/miniSticsC/crop. These parameters have no direct effect on crop or weed growth and development. They have an indirect effect as they determine how crop and weed growth affects soil hydrothermal variables which affect weed and crop germination and emergence, which in turn will determine weed growth and thus crop:weed competition.

### Files

|  |  |  |  |
| --- | --- | --- | --- |
| File name | Aim | Required? | What should the user do with it? |
| MatchSpecies.par | Correspondence between FlorSys species and STICS species | yes | Add the necessary lines if adding a new species to FlorSys |
| Other \*.par | STICS parameters | yes | Nothing, do not modify |
| \*.plt | Crop parameter values for STICS | yes | Nothing, do not modify |
| Param.sol | STICS parameters | yes | Nothing, do not modify |
| \*.tec | STICS parameters | yes | Nothing, do not modify |
| \*.usm | STICS parameters | yes | Nothing, do not modify |

Details on STICS parameters can be found in ParametersPlantsSTICS.xls.

### What to do when adding new species to FlorSys?

If you add a new species to FlorSys (section 4.4), you must also add this species to MatchSpecies.par, with a corresponding STICS species. When in doubt (notably for weed species), use crop for dicot species and orge for monocot species.

Do not modify or delete the other files comprised in Parameters/miniSticsC/crop.

# The weather files

## Weather

### Origin of weather files

07/09/2015

The weather files provided with FlorSys originate from the INRA Climatik platform. If you use these files for your own simulations, do not forget to acknowledge INRA Climatik.

### Location

06/05/2024

Weather files are located in DataBase/Climate (Climate/Climate in older FlorSys versions). File names must be LocationYYYY.dat (e.g. Dijon 1997.dat, Dijon1009.dat). To choose the weather files, list location (e.g. Dijon) in the configFile.dat of the virtual-field directory.

### Which weather years are used?

06/05/2024

If your simulation runs with true weather (TRUE option in configFile.dat) and your cropping system runs from YYYY (e.g. 1986) to YYYY' (2003), then the YYYY'-YYYY+1 (e.g. 19) weather files ranging from LocationYYYY.dat (e.g. Dijon1986.dat) to LocationYYYY'.dat (e.g. Dijon2003.dat) must be present in DataBase /Climate (Climate/Climate in older FlorSys versions).

If your simulation uses a list of weather years (usually a list of randomly chosen years), these years are listed in meteo.dat (in the virtual-field directory) and the corresponding locationYYYY.dat files must be in DataBase /Climate. This option is necessary to use the same list of random weather years for different virtual fields.

If your simulation chooses the weather years randomly, the range of years from which to choose is listed in configFile.dat and the corresponding locationYYYY.dat files must be in DataBase /Climate.

## Soil climate

### Estimated with STICS

Soil climate is usually estimated by FLORSY (via the connected STICS submodel) from weather, soil characteristics and cropping system of the virtual field. The STICS option must be chosen in configFile.dat.

### Measured

FLORSYS can also use measured hydrothermal soil variables. These soil-climate files must be located in Climate/Soil. They must be named as LocationYYYY.dat (e.g. SolDijon2001.dat) and location must be listed in configFile.dat (in the virtual-field directory). The weather option (section 6.1.3) determines which soil-climate files are necessary.

# How to set off a list of simulations

## Prepare the input files

For each virtual field to be simulated, the following steps must first be carried out:

* Prepare the virtual field (section 3)
* Choose the species to simulated (section 4.1)
* Introduce the weed species into the simulation (section 4.2)

Then, choose the virtual fields and the number of repetitions (section 7.2), and run the exe (section 7.3).

## Choose the list of virtual fields to simulate

06/05/2024

The list of virtual fields to simulate is listed in florsys.dat. This input file is located in the FLORSYS directory, where FLORSYS.exe is located. Fields are described by their path, either relative to the exe location (e.g. ./Fields/NoPloughMaizeMonoculture) or complete path names (e.g. c:/Nathalie/Simulations/WheatBarley). Caution, there must be **no blanks** in the directory names!

You also choose the number of repetitions in this file. If you run more than one repetition with the true weather (section 6.1.3), the difference between repetitions is only due to model stochasticity. If you want to run the repetitions with different weather series, you must list these series in meteo.dat or choose weather years randomly.

The writeFlorsysDat.R script automatically writes florsys.dat for all subdirectories of a chosen directory. R scripts are located in the "R script" directory.

## How to run FlorSys?

### The different FLORSYS versions

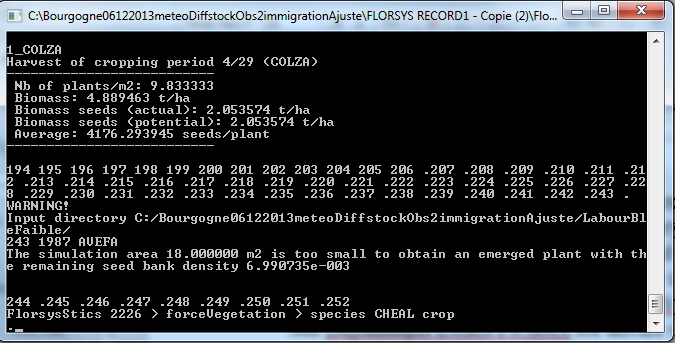
23/01/2024

FLORSYS exe files are named as "FLORSYSn ddmmyyyy weeds options.exe" with

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Possible options | Default submodels | Submodels that can be activated on demand |  |
| N | 2 |  | Root-system branched-broomrape |  |
|  | 3 | Root-system | N-competition seed-predation |  |
|  | 4 | Root-system seed-predation | Water-competition |  |
| ddmmyyyy | Date of exe creation |  |  |  |
| weeds | weeds | Simulations run with the initial weed seed bank and seed immigration data provided by the user |  |  |
|  | noweeds | Simulations run without weeds, even if the user entered data on initial weed seed bank and seed immigration |  |  |
| options | PHERA | branched-broomrape submodel activated |  |  |
|  | Predation | seed-predation submodel activated |  |  |
|  | N | N-competition submodel activated |  |  |
|  | H2O | Water-competition submodel activated |  |  |

### Set off a simulation

To set off FlorSys, double-click on the exe file (windows) or write FLORSYS.exe on the command file when located in the FLORSYS directory (e.g. C:/FLORSYS>). A black window will open in which messages with information on the simulation appear. These messages will also be copied to output files (section 7.4).



FlorSys simulates the virtual fields listed in florsys.dat (section 7.1) one after the other. If an error occurs for one virtual field (e.g. incorrect input file), the simulation is aborted for this field, an error message is produced (section 8) and FlorSys proceeds with the next virtual field listed in florsys.dat.

See DepannageFLORSYS:docx for advice in case of error.

## Error and warning messages

07/06/2015

When all listed virtual fields have been run, this is indicated in the execution widows (type ENTER to close the windows). If some of the simulation of one or several fields of the list was aborted, this is also indicted in the execution window. Details of the abortion causes are given in error.prn (section 8) located in the main directory, with the exe file.

Even if a simulation was run without error, warning messages are usually written to warning.prn, located in the virtual-field directory and its subdirectories (section 8). These messages indicate whether default values were used in case of missing, non-vital input files, whether parameters values were missing for some species, thus resulting in an absence of effect of the species (e.g. weed-impact indicators) or on the species (e.g. herbicide efficiencies with herbicides referred to by reference brand name, section 5.2). Always read this file to check whether input or parameter files must be completed.

Also look at output files to check whether all the required operations have indeed been executed, whether crops have emerged etc. This will help you to track errors in your input files that FlorSys has not detected. It might also help us to track remaining bugs in the source code that we have not yet identified, despite our efforts and time spent on this task!

## How to run parallel simulations

### Manually

01/12/2015

To run parallel simulations:

* create a new copy of the FLORSYS directory (or as several copies) (

|  |  |
| --- | --- |
|  | Florsys.dat file for FLORSYS13092015 |
| Florsys.dat for FLORSYS13092015 – Copie |

* Figure 2).
* Execute the steps described in sections 7.1, 7.2 and 7.3 for each FLORSYS directory.

|  |  |
| --- | --- |
|  | Florsys.dat file for FLORSYS13092015 |
| Florsys.dat for FLORSYS13092015 – Copie |

Figure 2. Parallel simulations with fields inside separate FLORSYS directories.

If you want to avoid distributing a set of virtual fields among the Fields directories of the various FLORSYS directories (Figure 3):

* Create a Fields directory outside the FLORSYS directories where you put all your virtual fields (section 7.1)
* Distribute the fields among the florsys.dat files of the various FLORSYS directories, indicating the complete path to reach the virtual fields (e.g. C:/Simulations/Fields/FieldA/) instead of relative paths (e.g. ./Fields/FieldA) (section 7.2)
* Set off each florsys.exe in each FLORSYS directory (section 7.3).

|  |  |
| --- | --- |
|  | Florsys.dat file for FLORSYS13092015 |
| Florsys.dat for FLORSYS13092015 – Copie |

Figure 3. Parallel simulations with fields outside separate FLORSYS directories.

Caution: do not run several executables (e.g. FLORSYS.exe and FLORSYSnoWeeds.exe) from the same FLORSYS directory. This will mess up the output directories, each exe overwriting and hindering the other exe file.

### Via a python script

17/08/2021

Ce script python a été écrit par Thibault Maillot <thibault.maillot@agrosupdijon.fr>

#### Installation de python (si ce n'est pas déjà fait)

updated 03/04/2023

Les étapes

* installer python en cochant "Add python to path" puis, dans l'installation avancé, coches 'install for all users'.

<https://www.python.org/ftp/python/3.7.0/python-3.7.0.exe>

* ouvrir une invite de commande en mode administrateur pour installer les paquets nécessaire avec les commandes suivantes
  + pip install scipy --user
  + pip install matplotlib --user
  + pip install pandas --user

Il peut être nécessaire de faire les étapes suivantes d'abord:

python -m pip install --upgrade pip --user

Il est possible d'avoir un message d'erreur du type "Could not install packages due to an EnvironmentError: [WinError 5] Accès refusé: 'c:\\program files (x86)\\python37-32\\Lib\\site-packages\\numpy' Consider using the `--user` option or check the permissions"

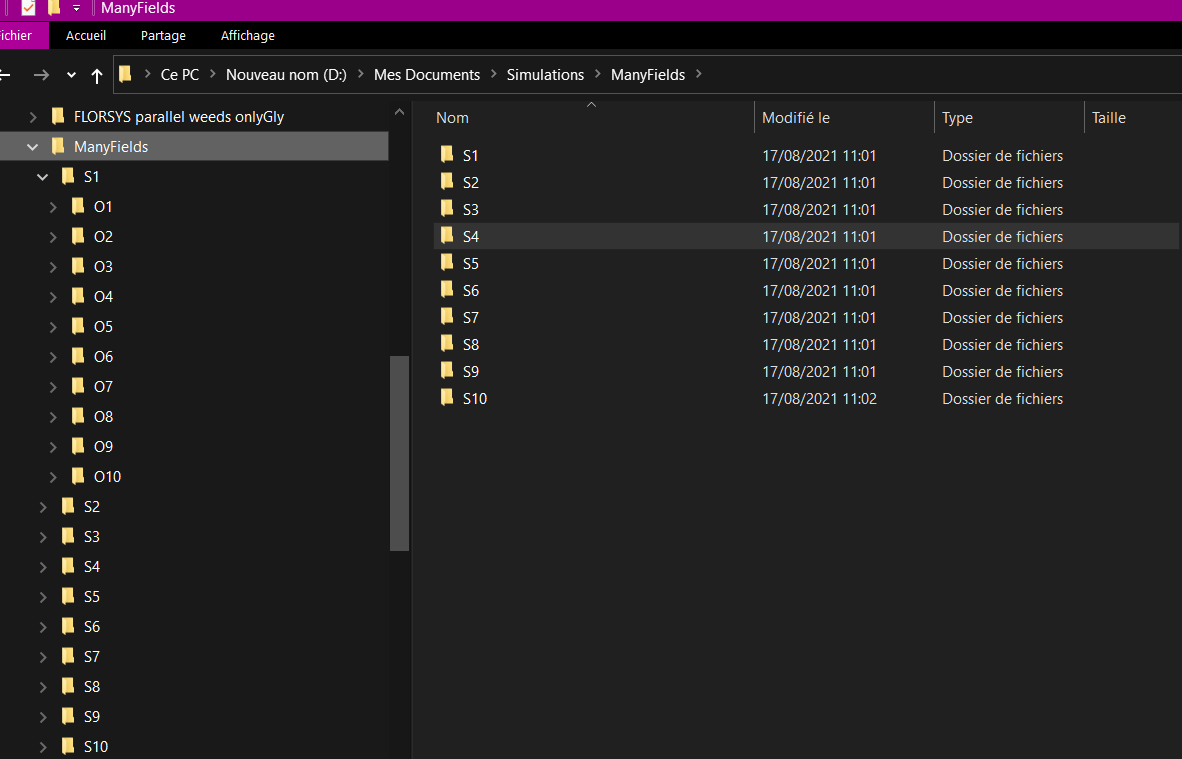
Dans ce cas-là: type "cmd" to the Start menu, right click cmd.exe, and run it as administrator

#### Exécuter

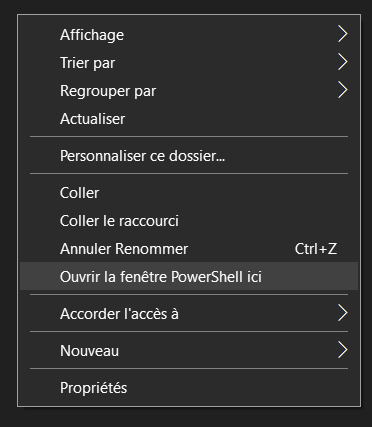
Updated 28/03/2024

* Si le répertoire "FLORSYS for parallel simulations with Python script" n'est pas livré, créer un répertoire "FLORSYSparallel" contenant les fichiers suivants
  + libFlorSys.py
  + script\_launchAllFields.py
  + le répertoire FLORSYS zippé et renommé en *Florsys\_v4\_CCUB.zip* (respecter la casse)
* rassembler tous les répertoires de simulation (champs virtuels) dans un répertoire appelé par exemple *ManyFields*. Il peut contenir des sous-répertoires regroupant des séries de champ par catégorie. Il est possible de rassembler des milliers de champs (organisés ou non dans des répertoires) dans *ManyFields.* Attention à ce qu'il n'y ait pas d'espace dans les noms de répertoires et éviter les caractères bizarres.

Dans l'exemple ici, il y a dix séries S1-S10 comprenant chacun 10 systèmes O1-O10



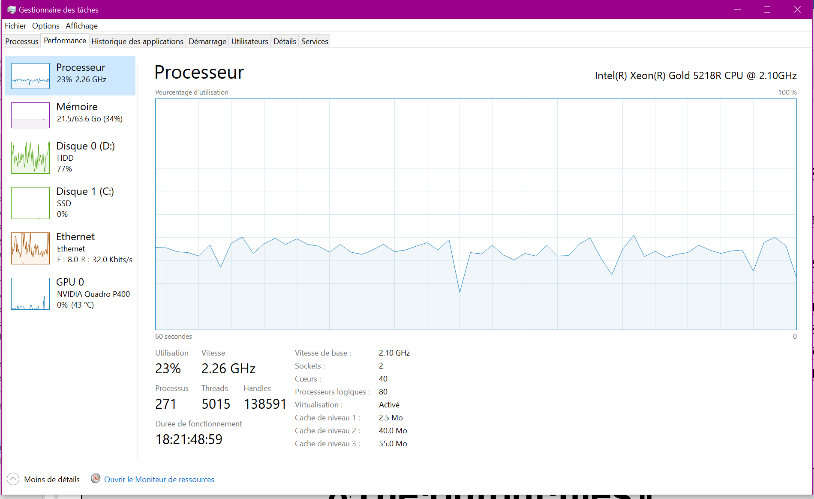
* ouvrir une fenêtre powershell dans FLORSYSparallel (shift-click droit dans ce répertoire puis *ouvrir la fenêtre powershell ici*)



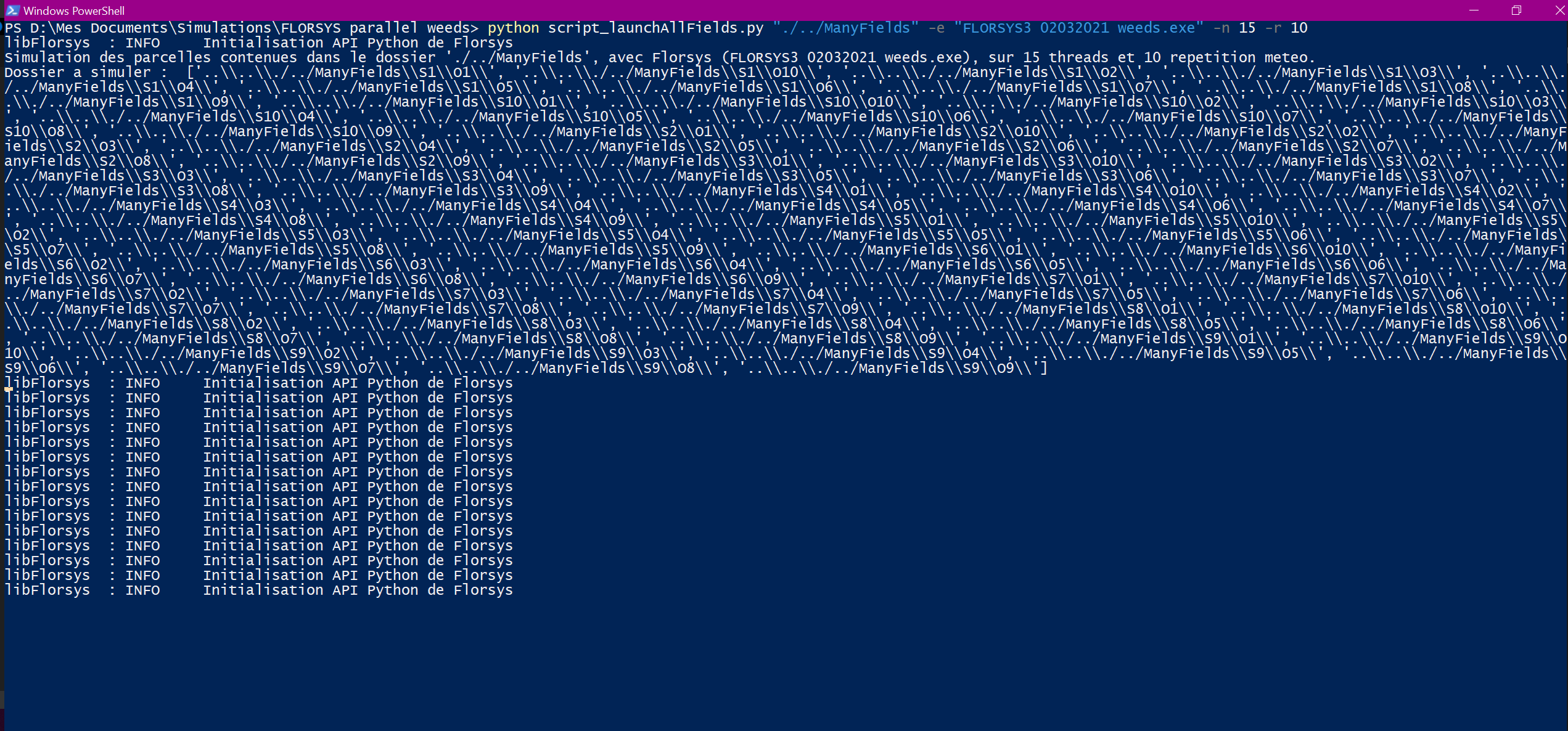
* taper la commande suivante dans le powershell

python script\_launchAllFields.py "./../ManyFields" -e "FLORSYS3 02032021 weeds.exe" -n 15 -r 10

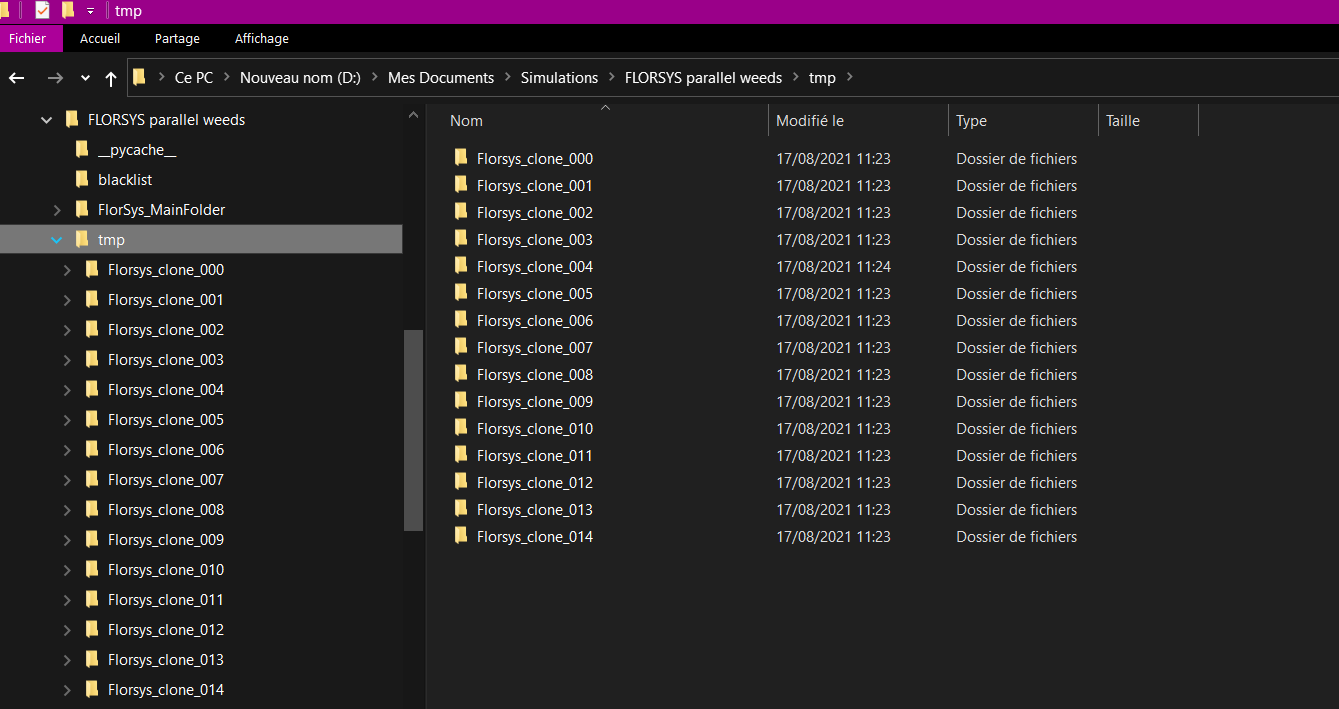
* + *python script\_launchAllFields.py* pour lancer le script
  + *"./../ManyFields"* donne le chemin depuis le script jusqu'au répertoire contenant tous les champs à simuler. Il faut mieux mettre le chemin en relatif (pas sûre que "C:/MesSimulations/ManyFields" fonctionne) et le chemin ne doit **pas contenir d'espaces** ("./../Mes Simulations/ManyFields" ne fonctionne pas).
  + *-e "FLORSYS3 02032021 weeds.exe"* indique le nom de l'exe FLORSYS à utiliser. Cet exe doit être dans le fichier *Florsys\_v3\_CCUB.zip*. Si ce zip contient d'autres exe FLORSYS (par exemple noweeds), il suffit de donner le nom de cet exe pour l'utiliser
  + *-n 15* indique le nombre de processeurs logiques à utiliser (ici 15). Ne pas utiliser tous les processeurs logiques dont dispose votre ordinateur, sinon il va bloquer et vous ne pouvez rien faire d'autre. Laisser au moins 2-3 processeurs libres. Pour voir le nombre de processeurs logiques, aller dans le gestionnaire de tâches de Windows

**

* + *-r 10* indique le nombre de répétitions à exécuter pour chaque champ (ici 10)
* Vous devez alors voir l'affichage suivant dans la fenêtre powershell

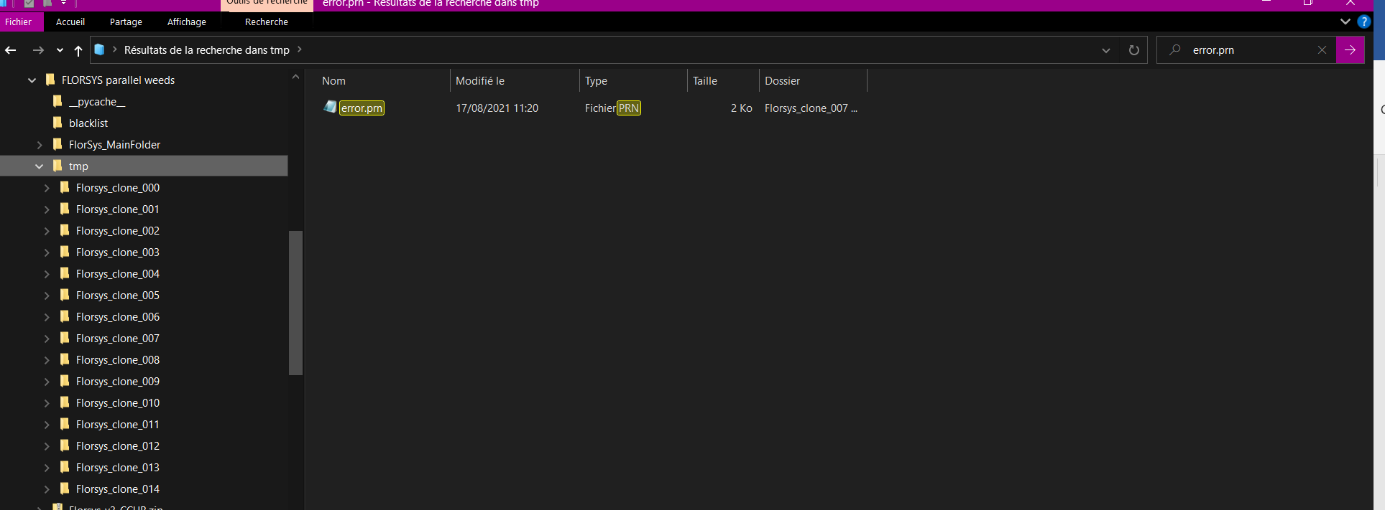


On y voit tout d'abord tous les champs qui seront simulés et ensuite le nombre de clônes créés. Les clônes se trouvent dans le répertoire *tmp* de *FLORSYSparallel*

**

Les champs à simuler sont automatiquement répartis entre les clônes (les copies de FLORSYS).

* La simulation peut durer des heures voire des jours ou semaines en fonction du nombre de champs à simuler. Lorsque c'est terminé, le mot *FIN* est affiché dans la fenêtre powershell et la ligne de commande est affichée.
* Vérifiez ensuite qu'il n'y ait pas d'erreurs dans les simulations en cherchant les fichiers *error.prn* dans les clônes (faire une recherche des ficheirs *error.prn* dans l'explorateur de fichiers

**

* Corriger si besoin les fichiers d'entrée des champs virtuels en question et détruire d'éventuels fichiers de sortie dans ce répertoire champ (les répertoires repetition1 etc et tous les fichiers \*.prn)
* Pour relancer FLORSYS sur les champs défectueux corrigés (sans toucher aux champs déjà correctement simulés), taper

python script\_launchAllFields.py "./../ManyFields" -e "FLORSYS3 02032021 weeds.exe" -n 15 -r 10 **-c**

Vous pouvez utiliser moins de clônes que précédemment (mais pas plus), en réduisant le nombre donné après *-n* (par *-n 8*)

# The output files

## Choice of output files

You choose the ouput files produced by FlorSys in output.dat in the virtual-field directory (section 1). The more output files you choose, the longer the simulation takes.

The frequency

## Location of output files

24/01/2024

Output files can be found in four directories:

* The FLORSYS directory: only error.prn (if it exists) is written to this directory
* The virtual-field directory: a few synthetic output files
* The repetition subdirectories located in the virtual-field directory: the crop and weed variables simulated by FlorSys
* The images subdirectory of each repetition subdirectory: picture files showing plant sizes and positions

Repetition and images directories are automatically created by FlorSys. If they exist from previous simulation runs of the virtual-field, they are overwritten.

## List of output files

Updated 24/01/2024

Open prn files with Notepad (blocnote) and svg with Gimp or web browser.

| Output file (\*.prn, except map.svg) | Directory | Content |
| --- | --- | --- |
| allPlantsY | Repetition | Detailed variables plant by plant, with one file per simulated year Y |
| annualPredation | Repetition | Annual predation rates and numbers of predated seeds (if seed-predation submodel is activated) |
| broomrape | Repetition | Component variables of broomrape indicator |
| cropFrostDamage | Repetition | Percentage biomass and plant loss due to frost for crops |
| crops | Repetition | Daily statistics on plant variables of each crop cohort of species. |
| crops\_and\_weeds | Repetition | Daily statistics on plant variables of each crop and each weed cohort of species. |
| CropYield | Repetition | Yield per crop species (produced by default) |
| CropEmergenceMap2D\_YYYY\_DDD | Images | Svg picture files with maps of all plants of the simulated field sample at the end of crop emergence |
| DeadPlants | Repetition | Cause of mortality of dead plants |
| DetailsPesticideLeaching | Repetition | Details for calculating pesticide-leaching reduction via pesticide absorption by root system |
| Diagnosis | Repetition | Details for evaluating the efficiency of cultural techniques in controlling weeds, per year. Tries to summarize approach described in section 8.4.2 |
| Emergence | Repetition | Daily emerged seedlings (before self-thinning) |
| EmergenceMap\_X\_Y | Repetition | Crop emergence map with coordinates of each emerged plant of crop species X during year Y |
| EndErosion | Repetition | details on weed contribution to reduce soil erosion |
| error | FLORSYS | Error messages for aborted simulations (if any) |
| Germination | Repetition | Daily germinated seeds for species, seed ages and soil layers, one file per simulated year Y |
| GerminationDates | Repetition | Germination onset dates for species, seed ages and soil layers, one file per simulated year Y |
| Indicators | Repetition | Indicators of weed harmfulness and benefits, per year |
| IndicatorsAggregated | Repetition | sustainability indicators aggregated over simulation length |
| Light3DinputYYYY | Repetition | Inputs for 3D light submodel, with one file for inputs and one for outputs, per calendar year |
| Light3DoutputYYYY | Repetition | outputs for 3D light submodel, with one file for inputs and one for outputs, per calendar year |
| Map2D\_YYYY\_DDD | Images | Svg picture files with maps of all plants of the simulated field sample. |
| onsetLeaching | Repetition | Dates when nitrate leaching starts first time after previous crop harvest |
| ReplacedSpecies | Virtual-field | List of species entered by user that were replaced by similar FLORSYS species during simulation, if any |
| Roots | Repetition | Root biomass and dimensions of root system (only if root submodel is activated) |
| RootVolume | Repetition | Root volume as well as intra and interspecific overlaps (only ir root submodel is activated) |
| SeedBank | Repetition | Daily seed bank (viable seeds in different layers and seed age classes) |
| SeedBankFinal | Repetition | Seed bank (viable seeds in different layers and seed age classes) at the last simulated day |
| SeedBankHarvest | Repetition | Seed bank (viable seeds in different layers and seed age classes) at harvest |
| SeedMigration | Repetition | Seed migration between fields (only valid for multi-plot simulation) |
| SoilClimateYYYY | Repetition | Soil climate variables predicted with STICS submodel for each simulated day and year YYYY |
| SoilNitrogen | Repetition | Total soil nitrogen available at cash crop sowing (only if nitrogen submodel is activated) |
| SoilNprofile | Repetition | Nitrogen available for plants in each soil layer (only if nitrogen submodel is activated) |
| SoilStructure | Repetition | Soil structures after each operation and winter |
| SowingPattern | Repetition | Number of rows sown per species or species mixture in field sample |
| sprayMapDDDYYY | repetition | Indicates for each voxel whether it is sprayed or not during a patch-sprayed herbicide application |
| Synthesis | Repetition | Synthetic output file for crop and weed densities at different stages before and after operations |
| synthItk | Virtual-field | Synthetic descriptors of cropping system components averaged over simulation (e.g. number of tillage operations averaged over simulation) |
| synthItkPerCrop | Virtual-field | Synthetic descriptors of crop management techniques averaged for each simulated crop species (e.g. number of tillage operations beefore wheat) |
| synthCropSuccession | Virtual-field | List of simulated primary (cash) crops |
| TakeAll | Repetition | Take-all disease incidence in crops |
| warning | Virtual-field  Repetition | Warning messages, .e.g. when default input files are used instead of those chosen by the user, when default values are used for missing non-vital parameters |
| WeedBiomassEPPO | Repetition | Daily weed biomass, one file per species |
| weedDetectionRates | Repetition | Weed plant detection rates for patch-sprayed herbicide applications |
| WeedCohortsEPPO | Repetition | Number of cohorts and plants for this species on each day, one file per weed species |
| weeds | Repetition | Daily statistics on plant variables of each weed cohort of species. |
| WeedSeedProductionEPPO | Repetition | Daily weed seed production, if any, one file per species |

## How to analyse output?

### Which statistics and output display?

02/08/2018

See section 10.4.

### How to understand low performance of a crop or a year?

13/09/2018

The subsequent steps apply to a low crop grain yield (or high yield loss) detected in indicators.prn.

Caution:

* do not forget that the cause of the problem might actually occur several years before the problem is actually detected in indicators.prn.
* do not forget that FlorSys simulates fixed lists of operations which are not adapted to weather conditions or simulated weed floras. The aim is to evaluate the impact of cropping systems on weeds, and not the impact of weeds and weather on cropping systems. The limits of "fragile" systems are thus overestimated.

Also see FAQ.doc, particularly sections 5 and 6.

And look at the new diagnosis.prn which tries to summarizes some of the steps described in section 8.4.2.2

#### Les stocks semenciers ne sont pas une bonne piste

Cela ne sert à rien de comparer les stocks finaux et initiaux. Le stock est une image à un instant t et ne donnera aucune information sur quelle technique ou évènement est à l'origine de l'augmentation de l'infestation ou de la disparition d'une espèce cultivée ou adventice.

#### Remonter dans le temps

Si on voit dans indicators.prn (ou ailleurs) qu'une culture ou année est fortement défaillante en production (ou pour un autre critère):

1. Gel Aller dans cropFrostDamage.prn pour vérifier que les fleurs de la culture n'ont pas gelées (🡪 pas de production semencière même si la culture survit) ou si la culture n'a pas perdu de biomasse ou est carrément morte suite au gel
2. Pas gel Si ce n'est pas le cas, aller dans synthesis.prn à la récolte de cette culture ou année. L'analyse de synthesis.prn est plus simple après copie dans excel, en activant le filtrage[[1]](#footnote-1) et en figeant les volets avec le curseur sur la cellule E2. **Attention, il peut être nécessaire de remonter plusieurs années pour trouver la cause de l'infestation adventice**
   1. Bon état à la récolte Si culture est présente, en forte densité et biomasse, vérifier son stade. Si la récolte est trop précoce par rapport à sa phénologie, le rendement indiqué dans indicators.prn est fortement réduit. Ce rendement est souvent supérieur à celui donné dans synthesis.prn (ou crops.prn) puisqu'il est calculé à partir de la biomasse de la culture, sans tenir compte du stade, pour pallier partiellement au problème de la possible inadéquation du module phénologique aux latitudes autres que les bourguignonnes. On peut aller éventuellement reculer la date de récolte, ou bien juste marquer dans son tableau de conclusion que cette faible performance est dû à un problème interne de FlorSys et non pas au système de culture.
   2. Réussite du semis? Si la culture est en mauvais état, vérifier tout d'abord que
      1. elle a bien été semée à la bonne densité
      2. elle a bien levé
      3. elle n'a pas été détruite par une opération de travail du sol ou herbicides mal positionnée ou mal choisie
      4. elle a levé dans un champ propre

Si besoin, corriger les entrées dans le fichier d'entrée itk.dat

* 1. Remonter dans le temps Si ce n'est pas un problème de description du semis dans itk.dat, remonter le temps dans synthesis.prn, soit à partir de la récolte de la culture (semis dans un champ propre, avec une levée de la culture satisfaisante), soit à partir du semis de la culture (semis dans un champ sale). Se concentrant sur les évènements particuliers:
     1. Semis dans un champ sale. Si le semis est fait dans un champ sale, les adventices ont une longueur d'avance que la culture peut avoir du mal à rattraper.
        1. Vérifier si le dernier travail du sol du sol est fait le jour du semis (en indépendant ou en association avec le semis). Ce point est crucial si il n'y a pas d'herbicides avant, avec ou juste après le semis.
        2. Vérifier si il y a des herbicides avant, avec ou juste après le semis. Ce point est crucial en semis direct.
        3. Vérifier si la culture de couverture a bien été détruite (gel, travail du sol, herbicides etc) avant le semis. Attention, le ROULEAU est insuffisant pour détruire des plantes (cultivées ou adventices) dans FlorSys. Ajoutez éventuellement un broyage (MOWING hauteur 0 cm) pour mimer un rouleau plus agressif, en attendant que FlorSys intègre ce type de rouleau
        4. Vérifier si les opérations de travail du sol et herbicides pré-semis étaient efficaces (voir ci-dessous)
        5. Les cultures de couverture peuvent souffrir des adventices levées dans le précédent, non détruites par la récolte et explosant une fois que la récolte a éliminé le couvert cultivé.
     2. Désherbage Est-ce que les herbicides et désherbages mécaniques sont efficaces pour détruire les adventices? Si ce n'est pas le cas:
        1. Est-ce que les herbicides appliqués sont renseignés dans herbicides.par et est-ce qu'ils sont efficaces sur les adventices présentes?
        2. Vérifier qu'il n'y a pas d'erreur de dose herbicide, surface travaillée, profondeur de travail etc pour les opérations dans itk.dat. Est-ce que toutes les opérations renseignées dans itk.dat sont effectivement simulées dans synthesis.prn[[2]](#footnote-2)? L'herbicide n'a pas tué la culture?
        3. Est-ce que le désherbage (chimique ou mécanique) est appliqué trop tard et n'a pas d'effet sur la flore?
        4. Est-ce que le désherbage (chimique ou mécanique) est appliqué trop tôt et loupe des levées adventices tardives?
        5. Le désherbage peut aussi être inefficace si la flore initiale est très abondante, indiquant un problème de maîtrise plus ancien et récurrent. Dans ce cas-là, remonter dans le temps.
        6. Attention: on ne voit pas toute l'efficacité des herbicides racinaires et pseudo-racinaires en comparant la flore avant et après l'opération. Ces herbicides sont persistants et continuent à tuer des semences germées pendant les jours et semaines qui suivent le traitement.
        7. Attention: le désherbage mécanique peut provoquer des vagues de germinations adventices.
     3. Travail du sol (voir aussi les points indiqués pour désherbage).
        1. Y a-t-il eu du travail du sol?
        2. Était-il efficace pour détruire la flore en place? L'efficacité augmente avec la profondeur de travail et la vitesse du tracteur; elle dépend des outils. Elle diminue avec la taille des adventices.
        3. Était-il efficace pour enfouir les semences adventices? Attention, cet effet ne se voit pas dans synthesis.prn, seulement dans seedBank.prn dont la sortie doit être activée dans output.dat et qui ralentit considérablement la simulation.
        4. Le faux semis n'est efficace pour vider le stock semencier s'il est fait en conditions humides. Attention: l'efficacité du faux semis se voit difficilement dans synthesis.prn, il consiste en une augmentation des germinations (pas nécessairement suvies de levées) dans les jours qui suivent l'opération.
        5. Attention: un travail en conditions humides proches du semis provoque des levées adventices en culture.
     4. Fauche/récolte
        1. La fauche ne tue les plantes le jour de l'opération que si elles ont commencé à fleurir (sauf les pérennes depuis la version juillet 2018 de FlorSys), avant elle ne fait que réduire la biomasse. Cette réduction de biomasse peut faire mourir les plantes dans les jours suivants si elles sont ombrées par des voisines et ont du mal à redémarrer.
        2. L'efficacité de destruction des adventices par la fauche ou la récolte est la plus forte si la hauteur de coupe est faible.
        3. La récolte a-t-elle laissé survivre beaucoup de petites adventices qui explosent une fois le couvert cultivé détruit? Ceci peut notamment être un problème pour les cultures de couverture semées juste après la récolte, sans travail du sol ou autre opération (comme du broyage par exemple).
     5. SeedShed:
        1. y a-t-il effectivement reproduction des adventices?
        2. Les entrées de semences peuvent aussi provenir de seedImmigration.dat
     6. Fumier.
        1. le fumier a-t-il introduit des semences adventices?
  2. Pérennes. Les cultures pérennes ne sont pas encore très bien modélisées dans FlorSys. Vérifier les points suivants:
     1. Éviter les variétés peu compétitrices (ex GALAXY pour LUZERNE)
     2. Éviter les durées supérieures à 3 ans

# Simulation strategies

## How to simulate an existing field?

Existing fields can be simulated for several reasons:

* to compare its weed and crop observations to simulated output, in order to evaluate the model prediction ability,
* to estimate crop and weed variables that are difficult to measure in fields.

To make the simulations as similar as possible as the existing field, you must:

* Fill in the cropping-system file (section 1) with the recorded crops and cultural operations, using exact dates and operation characteristics,
* Fill in the soil-characteristics file with soil texture and other characteristics measured in the field (section 1),
* Fill in the initial-seed-bank file (section 4.2.1) from seed samples taken at the first day of the simulation from the field. If no seed-bank measurements were carried out, estimate the initial seed bank from regional weed flora observations ([seed advice in Colbach *et al.*, 2016](#_ENREF_16)) but this results in a divergence between simulated and observed data during the first simulated years. This divergence is not due to deficiencies in model structure or badly estimated parameter values but to uncertainty in inputs;
* Fill in the other input files for describing the virtual field as best as possible ([seed advice in Colbach *et al.*, 2016](#_ENREF_16));
* Use the true weather (section 6.1.3).
* Ask for output on those day you carried out your weed and crop observations, and choose the relevant output files (section 8.1).
* Run 10 repetitions to take account of stochasticity.

## How to evaluate a cropping system?

26/11/2015

If you want to evaluate a cropping system (existing or prospective), most on the steps are similar to the previous section (section 9.1), with the following differences:

* You need not be as exact for the operation dates of the evaluated cropping system,
* You can use an initial seed bank comprising the weed species most abundant in the region ([see advice in Colbach *et al.*, in revision](#_ENREF_26)) and CalculateSeedBank.xlsx,
* Use a list of randomly chosen weather calendar years (section 6.1.3), and use the same list for the various cropping systems you want to compare. You will need a list comprising (N+1) ×R weather years if you want to simulate N cultural years and R repetitions,
* Run 10 repetitions to take account of stochasticity and weather variability.

An example can be found in Fields/Library/F1SoyaMaizeWheatMaize/

**Usually, several cropping systems are simulated and compared, rather than analysing absolute output values of a given cropping system**. Many analyses are possible, e.g.

* Analyses of variance and comparison of means of output variables (e.g. weed-impact indicators, weed species densities, seed bank densities etc), averaged over all years and repetitions,
* Weed dynamics (plant or seed densities) over time, for different cropping systems and/or species, averaged over repetitions,
* Probability (proportion of repetitions) that a given cropping system performs better than a control system (e.g. better yield, low weed-harmful indicators, higher weed-impact indicators), and risks of achieving the opposite of the initial aim (e.g. proportion of repetitions with lower yield etc),

See also section 10.4.

## How to assess crop yield loss?

Updated 21/02/2018

When running a virtual field with an initial weed seed bank, FlorSys will predict the crop seed yield for each crop of the simulated cropping system. To obtain crop yield loss due to crop:weed competition for light, run the same virtual field, but with an empty weed seed bank (section 4.2) and without seed immigration. Crop yield loss then is the difference in yields (read from indicators.prn and crops.prn output files, section 8) of simulations with and without weeds, relative to the weed-free simulation.

If you only want to run simulations with weeds, the ratio of weed biomass vs crop biomass at flowering onset of primary crop (cash crop) in indicators.prn is a good indicator of crop grain yield loss ([Colbach & Cordeau, 2018](#_ENREF_22)).

## What is the use of the repetitions

26/11/2015

To include variability in effects that cannot be described deterministically by FlorSys because of insufficient knowledge or mechanisms occurring at a smaller or larger scale than the cropping systems. Two types are distinguished:

* Variability due to variability (and unpredictability) of weather,
* Other variability

### Weather repetitions

Weather repetitions allows us to evaluate the robustness of a cropping system in different weather conditions. As weather cannot be predicted over large time spans, running simulations with different weather series allows us to perform frequency analyses, to determine the probability (e.g. 8 years out of 10, or 80%) that a system A is better than a system B, and the risk that the opposite occurs (e.g. 1 year out of 20, or 5%). Years are *weather years* and not years of a rotation.

### To include stochasticity

When running the simulations with the actual weather series (e.g. when evaluating the model with independent field observations), the differences between repetitions only result from stochastic effects in the model. Stochastic effects aim at including variability in effects that cannot be described deterministically by FlorSys because of insufficient knowledge or mechanisms occurring at a smaller or larger scale than the cropping systems. These are for instance:

* weed plant location vs. crop row location.
* weed plant mortality during a cultural operation: survival probability is calculated as a function of operation type, date, and options (e.g. herbicide spraying date, product, rate) as well as weed characteristics (e.g. species, plant size and location); to determine which weed plants actually die, a random number is drawn for each plant and compared to this probability.

## How to simulate various herbicide spraying strategies?

Herbicides can be either sprayed on a fixed day (section 9.5.1) or triggered by a weed density (section 9.5.2).

### At a fixed date

21/02/2018

Herbicides can be sprayed

* In the whole field, regardless of the position of crop and weed plants (Figure 4),
* On the crop rows only (Figure 5),
* In the interrow only even if this strategy does not seem very plausible (Figure 6),
* On the crop rows only, combined with interrow mechanical weeding (Figure 7),
* On weed patches only, which requires instructions in the cropping system input files (Figure 8) as well as an input file describing weed detection rates (weedDetection.dat). Weed detection rates depend on whether weeds are located in the interrow, the crop row or in the interface; they can be the same for all crops (Figure 9), or depending on crop species (Figure 11). A default weedDetection.dat file is located in Fields/DefaultField, a weedDetection.dat file in the simulation directory overrides the default,
* On the crop rows only, combined patch spraying in the interrow, which needs a judicious combination of instructions in the cropping system input file for herbicides (Figure 12) and sowing pattern (Figure 14) as well as in the weedDetection.dat file (Figure 13) to be added to the simulation directory.

For further details and instructions, see InputFLORSYS.xlsx

NEXT HERBICIDE 240 1994 TreflanC 2.5 L/HA GLOBAL

Figure 4. Example of instructions in the cropping system input file for a herbicide sprayed over the whole field, regardless of the position of crop and weed plants, here a TreflanC at 2.5 L/ha on 240 1994 (27 Aug 1994)

NEXT HERBICIDE 300 1994 Ankor 3 L/HA LOCAL ROW 10

Figure 5. Example of instructions in the cropping system input file for a herbicide sprayed on the crop rows only, here an Ankor at 3 L/ha on 300 1994 (26 Oct 1994) with a spraying width of 10 cm

NEXT HERBICIDE 300 1994 Ankor 3 L/HA LOCAL INTERROW 20

Figure 6. Example of instructions in the cropping system input file for a herbicide sprayed between the crop rows only, here an Ankor at 3 L/ha on 300 1994 (26 Oct 1994) with a spraying width of 20 cm

NEXT HERBICIDE 300 1994 Ankor 3 L/HA LOCAL ROW 10

NEXT MECHANICALWEEDING 300 1994 BINEUSE 6 0.7 2

Figure 7. Example of instructions in the cropping system input file for a combination of a herbicide sprayed on the crop rows only with mechanical weeding between crop rows, here an Ankor at 3 L/ha on 300 1994 (26 Oct 1994) with a spraying width of 10 cm on the crops rows and a hoe running at 6 km/ha and a depth of 2 cm, working 70% of the interrow

NEXT HERBICIDE 250 1994 Agil 1.2 L/HA PATCH 10 5 5

Figure 8. Example of instructions in the cropping system input file for a herbicide sprayed on weed patches only, here an Agil at 1.2 L/ha (the rate if the whole field were sprayed uniformly) on 250 1994 (6 Sept 1994) with a spraying width of 10 cm, starting 5 cm before the detected weed and continuing for 5 cm after the detected weed.

20170718

DEFAULT\_DETECTION\_RATES

ZONE DISTANCE\_CROP\_ROW\_CM

INTERFACE 5

INTERROW 6

WEED\_SPECIES ZONE WEED\_SIZE\_CM DETECTION\_RATE

ALL ALL 0 0

ALL ALL 1 0.5

ALL ALL 2 0.7

ALL ALL 3 0.99

END

ENDOFFILE

Figure 9. Example of instructions in the weedDetection.dat file for determining weed detection rates during patch spraying. Interface starts at 5 cm from crop row center, interrow zone at 6 cm. For determination of detection zones, see Figure 10. All weed species (WEED\_SPECIES is ALL) have the same detection rates, regardless of the zone (ZONE is ALL). Detection rate depends on weed size: plants ≥ 0 cm and < 1 cm have a 0 detection rate, plants ≥ 1 cm and < 2 cm have a 0.5 probability of being detected etc.



Figure 10. Determination of the three detection zones in WeedDetection.dat.

20170718

DEFAULT\_DETECTION\_RATES

ZONE DISTANCE\_CROP\_ROW\_CM

INTERFACE 5

INTERROW 6

WEED\_SPECIES ZONE WEED\_SIZE\_CM DETECTION\_RATE

ALL ALL 0 0

ALL ALL 1 0.5

ALL ALL 2 0.7

ALL ALL 3 0.99

END

-------------------------------------------------------

DETECTION\_RATES\_FOR\_THE\_FOLLOWING\_CROPS MAIS TOURNESOL END

ZONE DISTANCE\_CROP\_ROW\_CM

INTERFACE 7

INTERROW 8

WEED\_SPECIES ZONE WEED\_SIZE\_CM DETECTION\_RATE

DICOT ALL 0 0.1

MONOCOT ALL 0 0.05

DICOT ALL 1 0.2

MONOCOT ALL 1 0.3

DICOT ALL 2 0.8

MONOCOT ALL 2 0.9

END

-------------------------------------------------------

DETECTION\_RATES\_FOR\_THE\_FOLLOWING\_CROPS BLE!CEZANNE END

ZONE DISTANCE\_CROP\_ROW\_CM

INTERFACE 3

INTERROW 4

WEED\_SPECIES ZONE WEED\_SIZE\_CM DETECTION\_RATE

ALL ROW 0 0

ALL INTERROW 0 0.05

ALL INTERFACE 0 0.05

ALL ROW 1 0.1

ALL INTERROW 1 0.5

ALL INTERFACE 1 0.5

ALL ROW 2 0.2

ALL INTERROW 2 0.7

ALL INTERFACE 2 0.7

END

ENDOFFILE

Figure 11. Example of instructions in the weedDetection.dat file for determining weed detection rates during patch spraying. Default detection rates are given in the first part (DEFAULT\_DETECTION\_RATES) and are the same as in Figure 9. Detection rates for MAIS and TOURNESOL are different, with a larger crop row zone (7 cm), discriminating monocots and dicots, with only three plants sizes ([0,1[, [1,2[, ≥2 cm). In BLE!CEZANNE, the crop row zone is smaller (3 cm), and detection discriminates the three zones (ROW, INTERROW, INTERFACE). For any other crops, the default detection rates are applied.

NEXT HERBICIDE 120 1994 Ankor 3 L/HA LOCAL ROW 10

NEXT HERBICIDE 120 1994 Ankor 3 L/HA PATCH 10 5 5

Figure 12. Example of instructions in the cropping system input file for a combination of a herbicide sprayed on the crop rows with patch spraying between crop rows, here an Ankor at 3 L/ha on 120 1994 (29 April 1994) with a spraying width of 10 cm on both the row and the interrow and a spraying lag before and after the detected weed in the interrow of 5 cm. To limit the patch spraying to the interrow only, the weedDetection file needs to be adapted (Figure 13). To work properly, the interrow width of the crop sowing pattern must be a multiple of the spraying width (Figure 14).

20170718

DEFAULT\_DETECTION\_RATES

ZONE DISTANCE\_CROP\_ROW\_CM

INTERFACE 5

INTERROW 6

WEED\_SPECIES ZONE WEED\_SIZE\_CM DETECTION\_RATE

ALL ALL 0 0

ALL ALL 1 0.5

ALL ALL 2 0.7

ALL ALL 3 0.99

END

-------------------------------------------------------

DETECTION\_RATES\_FOR\_THE\_FOLLOWING\_CROPS MAIS END

ZONE DISTANCE\_CROP\_ROW\_CM

INTERFACE 7

INTERROW 7

WEED\_SPECIES ZONE WEED\_SIZE\_CM DETECTION\_RATE

ALL ROW 0 0

ALL INTERFACE 0 0

ALL INTERROW 0 0

ALL INTERROW 1 0.2

ALL INTERROW 2 0.99

END

ENDOFFILE

Figure 13. Example of instructions in the weedDetection.dat file for determining weed detection rates during patch spraying, here for patch spraying the interrow zone only. Detection rates in the row and interface are nil; only weeds in the interrow are detected. This example is particular to the instructions for the cropping system file of Figure 12.

NEXT SOWING 100 1994 NO 80 0 YES YES

1

MAIS PRIMARY 6 2 NONE

Figure 14. Example of instructions in the cropping system input file for determining a sowing interrow width compatible with the herbicide spraying strategy combining systematic row spraying and interrow patch spraying (Figure 12, Figure 13)

### Triggered by a weed density

25/02/2018

If herbicide spraying is triggered by a weed density, further instructions are necessary, in addition to those of section 9.5.1 which describe whether herbicides are sprayed over the whole field or only a particular sections of the field. These instructions are given after the product rate and unit (e.g. L/HA or KG/HA) and before the spraying pattern (i.e. GLOBAL, LOCAL, PATCH). They include:

* The IF keyword
* The end date of the potential spraying period. If the triggering density was never exceeded between the operation date and the end date, the operation will not be carried out
* The weed species triggering the spraying, either a species listed in the species.dat file, or one of the following keywords:
  + ALL (all weed species are considered
  + MONOCOT (only monocot weed species are considered
  + DICOT (only dicot weed species are considered
* The weed density (plants/m², >= 0) triggering the spraying operation

NEXT HERBICIDE 86 2006 STRATOSultra 1 L/HA IF 120 2006 GERDI 10 GLOBAL

Figure 15. Example of instructions in the cropping system input file for a herbicide operation triggered via a weed density. Here STRATOSultra is applied at 1 L/ha the first time GERDI plant density exceeds 10 plants/m² between 86 2006 and 120 2006. The whole field will be sprayed (GLOBAL option, see section 9.5.1). If the triggering density has not been exceeded before 120 2006, the herbicide will not be sprayed.

## How to simulate manual weeding

09/11/2020

Two types of manual weeding can be simulated:

* Pulling out plants manually (section 9.6.1)
* Weeding with a hoe (section 9.6.2)

### Actual manual weeding

09/11/2020

To simulate manual weeding (i.e., pulling out plants by hand), use a herbicide spraying operation:

*Operation type Operation date Herbicide product Rate and unit Sprayed field part*

NEXT HERBICIDE 100 1985 MANUAL\_WEEDING 1 L/HA GLOBAL

The applied herbicide product must be MANUAL\_WEEDING (or DESHERBAGE\_MECANIQUE) applied at 1 L/ha. The operation can be

* GLOBAL (the whole field is weeded)
* Or LOCAL   
  Caution: LOCAL is only accepted in row-sown crops; in case of successive sowings, the rows of the last-sown crops are used.   
  Indicate treated part
  + INTERROW (inly the interrow is weeded)
  + Or ROW (only the crop row is weeded)
  + and width of weeding (in cm). Rows are those of the most recent row sowing

### Manual mechanical weeding

For hand-held hoeing, use a BINEUSE applied to INTERROW, shallow depth (e.g. 2 cm). Indicate the usual tractor speed (e.g. 6 km/h) to simulate the high precision/aggression of the manual weeding, even if the operation proceeds at a much lower speed

*Operation type Operation date Tool Tractor Weeded field Prop Tillage*

*speed part weeded depth*

*(km/h) field (cm)*

NEXT MECHANICALWEEDING 300 1994 BINEUSE 6 INTERROW 0.7 2

## How to simulate crop volunteers

24/02/2018

The easiest way is to enter a non-zero seed loss rate at harvest in the cropping system input file (Figure 16). The lost seeds result in crop volunteers which are them simulated as weeds. This means that the seed-bank parameters that are not necessary for crop species must be given (e.g. seed mortality or dormancy). To date, these parameters are available for only two crop species in FlorSys, i.e. winter oilseed rape (COLZA) and winter wheat (BLE). To make herbicides work on crop volunteers, you must add the efficiency of the applied herbicides to herbicidesPERSO.par (Figure 17). At present, no herbicides are active against crop volunteers!

For seed loss data, see ([Gruber *et al.*, 2008](#_ENREF_29)). Seed loss in winter wheat is in average 2%, in oilseed rape, it can be above 10% and sometimes close to 100% in case of catastrophic weather events.

Caution: oilseed rape volunteers are very harmfulness, they very much reproduce and reduce crop yield. The parameters for wheat volunteers were estimated very roughly, particularly seed mortality and dormancy. This part of FlorSys has not yet been evaluated.

NEXT HARVEST 197 2006 50 1 COLZA 0.05

Figure 16. Example of instructions in the cropping system input file for harvest seed loss, here with 5% seed loss in oilseed rape harvest on 197 2006 (15 July), with a cutting height of 50 cm

commercial\_name active\_ingredient systemic root pseudo-root foliar rate unit\_rate persistence\_max species preEmergence cotyledon seedling vegetative

Archipel iodosulfuron-methyl-sodium(3%)+mesosulfuron-methyl(3%) 1 0 0 1 0.25 KG/HA 0 COLZA 0 1 1 1

Figure 17. Example of instructions in the herbicidesPERSO.par parameter file for making the Archipel herbicide kill off oilseed rape (COLZA) plants at a 100% efficiency for the cotyledon, seedling and vegetative stages, when applied at 0.25 kg/ha.

## How to simulate herbicide resistance

13/03/2019

See "herbicide resistance" sheet in InputFLORSYS.xlsx.

## How to simulate branched broomrape *Phelipanche ramosa* (PHERA)

13/03/2019

### Which FlorSys version?

You can only simulate PHERA (*Phelipanche ramosa*) if you have the FlorSys exe including the PheraSys submodel. Standard FlorSys does not include this submodel at present.

### Which inputs?

* PHERA must be activated in species.dat. Preferably do this in your simulation directory (copy species.dat there and activate PHERA) and not in Parameters/Species because otherwise, standard FlorSys will not work.
* PHERA must be listed in the initial seed bank (file name chosen in config.dat) or in the regional seed immigration file (seedImmigration.dat).

### Which outputs?

PHERA state variables comparable to those of non-parasitic weeds are given in the usual weed output files (section 8, OutputFLORSYS.xlsx). State variables specific to parasite behaviour (e.g. number of attachments) are added to synthesis.prn.

### What about parameters?

13/03/2019

Parameter values for PHERA are listed in the parameter files, even for the standard FLORSYS version. These though only comprise the parameters that describe "conventional" weed behaviour (e.g. seed mortality in soil). Parameter values specific to parasite behaviour are at present inside the source code.

The attaching ability of species is taken from PhelipancheCrop.par and PhelipancheWeed.par which are used to calculate the broomrape risk due to weeds in the standard FLORSYS version.

There is one additional parameter file called PHERASYS.par which lists the germination-triggering ability of the host species as well as their root diamater (which drives the triggering and attaching root volume). This file is also distributed with the standard FlorSys version.

Other parameters are written into the code and cannot be modified at present.

# The FlorSys model

See FLORSYS content.docx for a detailed description of the model content.

Please do not forget to cite the FlorSys references when presenting the model or simulations run with FlorSys.

## Synthetic description

09/11/2020

A synthetic description of the FlorSys model structure, evaluation (partial) and use can be found in ([Colbach *et al.*, 2014a](#_ENREF_13); [Colbach *et al.*, 2020b](#_ENREF_25)).

## Detailed model structure

09/11/2020

The details of the model life-cycle can be found in ([Gardarin *et al.*, 2012](#_ENREF_28); [Munier-Jolain *et al.*, 2013](#_ENREF_35); [Colbach *et al.*, 2014b](#_ENREF_14); [Munier-Jolain *et al.*, 2014](#_ENREF_36)) and in FLORSYS content.docx.

The weed-impact indicators were developed by ([Mézière *et al.*, 2015](#_ENREF_32); [Colbach *et al.*, 2017b](#_ENREF_18); [Colbach *et al.*, 2020a](#_ENREF_24); [Moreau *et al.*, 2020](#_ENREF_33)).

## Detailed model evaluation

13/03/2019

The following submodels were evaluated separately:

* Seed movements during mouldboard ploughing ([Colbach *et al.*, 2000](#_ENREF_5); [Roger-Estrade *et al.*, 2001](#_ENREF_40))
* Weed emergence (monospecific prototype) ([Colbach *et al.*, 2006](#_ENREF_7))
* Short-term multispecific weed emergence ([Gardarin, 2008](#_ENREF_27))
* Light penetration into the 3D canopy ([Munier-Jolain *et al.*, 2013](#_ENREF_35))

The complete model was evaluated with independent field observations by ([Colbach *et al.*, 2016](#_ENREF_16); [Pointurier *et al.*, in revision](#_ENREF_37)). The current version was reevaluated, using the same data and methodology. The following table summarizes the main results from the best documented cropping-system trial:

Summary:

* The model is better at ranking than at predicting absolute values.
* Daily weed species densities and above-ground biomass are well within the observed dynamics, without bias
* Cropping systems are satisfactorily ranked in terms of weed species densities and biomasses, without bias
* Situations (cropping systems x years) are correctly ranked in terms of weed species seed bank, without bias
* Crop biomass and yield are satisfactorily ranked, without bias.
* Variables at the weed community level tend to be overestimated
* Observation variability often makes it difficult to discriminate between model error and variability in weed flora or crop variables
* Increased field-sample area reduces understimation of crop yield and overestimation of weed community variables (without effect on ranking ability) but takes more time to simulate

Table 1. Summary of multi-annual evaluation of FlorSys, using the data from the INRA Dijon-Époisses cropping-system trial. FlorSys version with root submodel (including remobilization after flowering and after frost damage), snow submodel, improved frost parameters, crop phenology tailored to harvest date and 10x10m² field sample area

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | Species scale | Temporal scale | Relative bias (%) § | Relative prediction error (%)$ | Proportion of correctly predicted observations | | | | |
| Average values | | Daily dynamics x | | |
| Prop & | In terms of | Correct | Over-estimated | Under-estimated |
| Crop yield (t/ha) | Per species | Day | -8% | 110% | 0.42 | Absolute values |  |  |  |
| Crop biomass (g/m²) | Per species | Day | -2% | ~0 | 0.59 | Rank |  |  |  |
| Weed seed bank (seeds /m²) | Sum | Day | 15% | ~0 | -0.08 | Rank |  |  |  |
| Per species | Day | 7% | 74% | 0.51 | Rank |  |  |  |
| Weed biomass (above-ground) (g/m²) | Sum | Multiannual mean | 206% | ~0 | 0.13 | Rank |  |  |  |
| Per species | 17% | ~0 | 0.55 | Rank |  |  |  |
| Sum | Day | 69% | 322% | 0.28 | Rank | 0.24 | 0.68 | 0.08 |
| Per species | 4% | 488% | 0.36 | Rank | 0.79 | 0.14 | 0.07 |
| Weed plants /m² | Sum | Multiannual mean | 154% | 228% | 0.65 | Relative values |  |  |  |
| Per species | 17% | 148% | 0.67 | Rank |  |  |  |
| Sum | Day | 32% | 156% | 0.21 | Relative values | 0.34 | 0.55 | 0.11 |
| Per species | 7% | 159% | 0.30 | Rank | 0.86 | 0.10 | 0.04 |

§ en relatif par rapport à la gamme de variation des observations (max-min)/2. Couleurs: du vert (0%) au rouge (|50%|), gris (observations trop variables pour conclure). $ Corrigé pour la variation des observations et des simulations, en relatif par rapport à la déviation standard des observations. Couleurs: rouge (mauvais, > 120%), jaune (satisfaisant, 60-90%), vert clair (bon, 30-60%), vert (très bon, < 30%) et gris (observations trop variables pour conclure). & Maximum de l'efficacité de modélisation et des coefficients de corrélation de Pearson et Spearman. Couleurs: du rouge (0) à vert (1). x Proportion d'observations inclues dans l'intervalle de confiance simulé. Couleurs: du rouge (0) à vert (1) pour la première colonne, du vert (0) au rouge (1) pour les deux autres colonnes.

## Examples of model use

### Literature

13/03/2019

([Colbach *et al.*, 2014a](#_ENREF_13)) summarizes the model as well as many simulation case studies. The following examples of model use have already been published:

* Evaluating whether reconciling production and biodiversity is easier inside each field or at the field-cluster scale ([Colbach *et al.*, 2018](#_ENREF_23))
* Evaluating how necessary herbicides are for weed management and whether they can be replaced by alternative preventive and curative measures ([Colbach & Cordeau, 2018](#_ENREF_22))
* Designing innovative cropping systems to reconcile crop production, biodiversity and low herbicide use ([Colbach *et al.*, 2017c](#_ENREF_19))
* Effect of management practices on glyphosate resistant weeds and impact on crop production and biodiversity ([Colbach *et al.*, 2017d](#_ENREF_20); [Colbach *et al.*, 2017e](#_ENREF_21))
* Assessing broomrape risk due to weeds in cropping systems([Colbach *et al.*, 2017a](#_ENREF_17))
* Impact of changes in cropping practices (e.g. accompanying the introduction of novel crop varieties) on weed-impact indicators by comparing innovative practices to the existing control ([Bürger *et al.*, 2015](#_ENREF_2)),
* Which species traits are selected by changes in cultural practices ([Colbach *et al.*, 2014c](#_ENREF_15)),
* Evaluating different crop sowing patterns for their effect on crop yield loss and weed biomass ([Colbach *et al.*, 2014b](#_ENREF_14)),
* Evaluating the risk of additional crop disease due to weeds, using the monospecific prototype of FlorSys ([Mézière *et al.*, 2013](#_ENREF_31)),
* Evaluating the additional weed infestation due to spreading seed-infested manure, using the monospecific prototype ([Colbach *et al.*, 2013b](#_ENREF_12)),
* Sensitivity analyses to cropping system components, using the monospecific prototype ([Colbach *et al.*, 2013a](#_ENREF_10); [Colbach & Mézière, 2013](#_ENREF_11)),
* Probabilities of success and failure of reducing grass weeds with diversified crop rotations, using the monospecific prototype ([Colbach *et al.*, 2010b](#_ENREF_9)),
* Probabilities of success and failure of non-chemical weeding strategies, using the monospecific prototype ([Colbach *et al.*, 2010a](#_ENREF_8)),

See also ([Bergez *et al.*, 2010](#_ENREF_1)) on how to design crop management systems by simulation.

### Examples of output display

06/02/2018

The most frequently used output can be found in section 10.4.2.3

#### Multiannual dynamics



Figure 18. Impact of a change in management practices in weed infestation. Weed densities over time simulated for two crop rotations, which a change from annual mouldboard ploughing to direct sowing in 1993/1994

#### Single-criteria evaluation

|  |  |  |
| --- | --- | --- |
|  | Plough | No plough |
| Optimal spraying conditions | A | B |
| Sup-optimal conditions | C | D |

Figure 19. Evaluation of prospective rotations for grass weed control with AlomySys as a function of herbicide treatment conditions and primary tillage. Each scenario was simulated 10 times with randomly chosen climate series from Dijon, Burgundy. The left-hand axis shows the medium-term weed infestation, distinguishing the reference system (black bars) and prospective scenarios (green, blue and red bars indicating whether 0%, 10% or >10% of repetitions with infestation > reference). The right-hand axis indicates the risk of long-term weed increase (yellow bars). ([Colbach *et al.*, 2010b](#_ENREF_9))

#### Multicriteria tables

This is the format most useful for comparing cropping systems. Tables can present either details on all weed impacts (Table 2) or aggregated scores (Table 3). Also see section 10.4.2.8.

Table 2. Comparison of cropping systems. Case study investigating the consequences of the introduction of glyphosate-tolerant maize on managment practices and weed impacts on biodiversity and crop production ([Colbach *et al.*, 2017d](#_ENREF_20); [Colbach *et al.*, 2017e](#_ENREF_21)). Cells of mean values (Mean) are coloured from red (lowest value of a given column) to green (highest value) for biodiversity indicators, from green (lowest value of a given column) to red (highest value) for weed harmfulness indicators. Values of a given column followed by the same letter are not significantly different at p=0.05. Means in bold are significantly different from zero at p=0.05.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Cropping system* | *Species*  *richness* | | | *Species*  *equitability* | | | *Bird*  *food* | | | *Carabid*  *food* | | | *Bee*  *food* | | | *Yield*  *loss* | | | *Harvest*  *pollution* | | | *Harvesting*  *problem* | | | *Field*  *infestation* | | |
| Soya/Maize/Wheat/Maize | 15.62 | B |  | 0.30 | GH |  | 6.01 | C |  | 2.96 | C |  | 1.46 | D |  | 41.53 | CB |  | 2.72 | BA |  | 3.09 | B |  | 1.49 | DC |  |
| Soya/HTmaize/Wheat/HTmaize | 16.49 | A |  | 0.29 | H |  | 6.09 | C |  | 3.05 | C |  | 1.58 | DC |  | 43.62 | B |  | 2.65 | B |  | 2.78 | C |  | 1.61 | C |  |
| + no mouldboard plough | 9.34 | H |  | 0.37 | F |  | 3.28 | F |  | 2.30 | D |  | 0.59 | F |  | 19.76 | D |  | 1.04 | D |  | 1.24 | E |  | 0.87 | E |  |
| Wheat/HTmaize | 10.42 | G |  | 0.34 | GF |  | 0.92 | G |  | 2.02 | E |  | 1.18 | E |  | 20.30 | D |  | 1.63 | C |  | 1.94 | D |  | 0.37 | F |  |
| + no mouldboard plough | 14.16 | C |  | 0.24 | I |  | 6.58 | B |  | 4.66 | B |  | 1.63 | C |  | 60.16 | A |  | 2.92 | A |  | 3.39 | A |  | 2.14 | A |  |
| HTmaize monoculture | 11.17 | F |  | 0.12 | J |  | 5.52 | D |  | 1.88 | E |  | 1.11 | E |  | 1.08 | E |  | 0.32 | E |  | 0.56 | F |  | 0.01 | G |  |
| + early sowing | 10.56 | GF |  | 0.52 | E |  | 6.14 | C |  | 1.31 | F |  | 0.51 | F |  | 1.86 | E |  | 0.89 | D |  | 1.00 | E |  | 0.31 | F |  |
| + late sowing | 12.89 | E |  | 0.35 | F |  | 5.44 | ED |  | 2.05 | E |  | 1.52 | DC |  | 0.26 | E |  | 0.18 | FE |  | 0.41 | F |  | 0.01 | G |  |
| + no mouldboard plough | 8.09 | I |  | 0.70 | B |  | 5.25 | E |  | 0.59 | G |  | 0.16 | G |  | 0 | E |  | 0.02 | F |  | 0.02 | G |  | 0 | G |  |
| + no plough + early sowing | 6.32 | J |  | 0.76 | A |  | 5.17 | E |  | 0.01 | I |  | 0.04 | G |  | -7.20 | F |  | 0 | F |  | 0 | G |  | 0 | G |  |
| + no till | 13.78 | DC |  | 0.24 | I |  | 9.65 | A |  | 8.69 | A |  | 2.29 | A |  | 39.48 | CB |  | 2.76 | BA |  | 3.12 | B |  | 1.88 | B |  |
| + no till + 2nd glyphosate | 14.05 | DC |  | 0.22 | I |  | 9.63 | A |  | 8.70 | A |  | 2.09 | B |  | 37.59 | C |  | 2.83 | BA |  | 3.08 | B |  | 1.35 | D |  |
| + no till + 2nd gly. + early sow. | 13.48 | DE |  | 0.23 | I |  | 9.64 | A |  | 8.70 | A |  | 2.21 | BA |  | 38.15 | C |  | 2.84 | BA |  | 3.19 | BA |  | 1.65 | C |  |
| + catch crop killed with glyph. | 4.37 | K |  | 0.59 | D |  | 0.04 | H |  | 0.26 | H |  | 0.11 | G |  | -0.12 | E |  | 0.01 | F |  | 0.03 | G |  | 0 | G |  |
| + catch crop killed with tillage | 4.84 | K |  | 0.65 | C |  | 0.06 | H |  | 0.76 | G |  | 0.04 | G |  | -0.28 | E |  | 0.06 | F |  | 0.07 | G |  | 0 | G |  |

Each cropping system started with the same initial weed species pool characteristic of Aquitaine, was simulated over 30 years and repeated with the same 10 weather series consisting of randomly chosen weather records from Aquitaine.

Table 3. Multi-criteria performance simulated by FlorSys for existing reference cropping systems (R) and alternative systems (A, O) aiming to reconcile weed harmfulness control and reduced herbicide use. For weed impact scores, see Table 4. ([Colbach *et al.*, 2017c](#_ENREF_19)). Cells were coloured from green for best performance (A) to red for worst performance (E), and the stronger the colour, the higher the probability for the score

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Strategy | Modifications applied to analysed cropping system | | Multi-criteria performance score (probability) | | | | | | | |
| A | A- | B | B- | C | C- | D | E |
| R | Reference (Table 3) | | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.1 | 0.9 |
| R' | Replace withdrawn herbicides by authorized herbicides | | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.3 | 0.7 |
| A1 | Replace one pseudo-root by one multi-entry herbicide | | 0 | 0 | 0 | 0.1 | 0.1 | 0.0 | 0.6 | 0.2 |
| Introduce sunflower | |
| A2 | Replace oilseed rape by lucerne | | 0 | 0 | 0 | 0 | 0 | 0.0 | 0 | 1.0 |
| A3 | OSR/wheat, delete one herbicide in OSR, adapted tillage date before OSR to later harvest of wheat (vs. barley) | | 0 | 0 | 0 | 0.1 | 0.3 | 0.0 | 0.1 | 0.5 |
| A3' | Same as A3 with mechanical weeding in winter oilseed rape | | 0 | 0 | 0 | 0 | 0.4 | 0.0 | 0 | 0.6 |
| A4 | Replace one pseudo-root by one multi-entry herbicide | | 0 | 0 | 0 | 0.4 | 0.2 | 0.0 | 0.1 | 0.3 |
| PRE herbicides in OSR closer to sowing to be included in in-crop herbicides, additional herbicide in barley | |
| Replace plough by discs because of short fallow periods | |
| A5 | Add spring pea | OSR/wheat/pea/wheat | 0 | 0 | 0 | 0.3 | 0.1 | 0.0 | 0.1 | 0.5 |
| Wheat instead of barley |
| A6 | Foliar herbicide instead of pseudoroot in barley | | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.3 | 0.7 |
| PRE OSR herbicide closer to sowing to be included in in-crop herbicides | |
| Spring foliar instead of autumn foliar herbicide in OSR | |
| Spring foliar instead of autumn pseudo-root in barley | |
| O | A5 + mechanical weeding in OSR (A3') + PRE herbicide closer to OSR sowing (A4, A6) | | 0 | 0 | 0 | 0.2 | 0.2 | 0.0 | 0.3 | 0.3 |

#### Decision trees



Figure 20. Decision tree for minimizing crop grain yield loss ([Colbach & Cordeau, 2018](#_ENREF_22)). Effects of management practices averaged over rotation on crop grain yield loss (YL) assessed at the multi-annual scale in simulations with and without herbicides identified with a regression tree (N=number of cropping systems x weather repetitions corresponding to the terminal leaf). Bold variables indicate the primary splitting variable, standard fonts show surrogate variables. In each box, variables are ranked from most to least influential variables, based variable importance VIP (R² = 0.59, details in section C.9 online). For each split, green and red lines show branches that respectively decrease and increase yield loss. Final leaves are coloured from green for the lowest yield loss on the left to red for the highest yield loss on the right.

#### Trade-offs among weed impacts

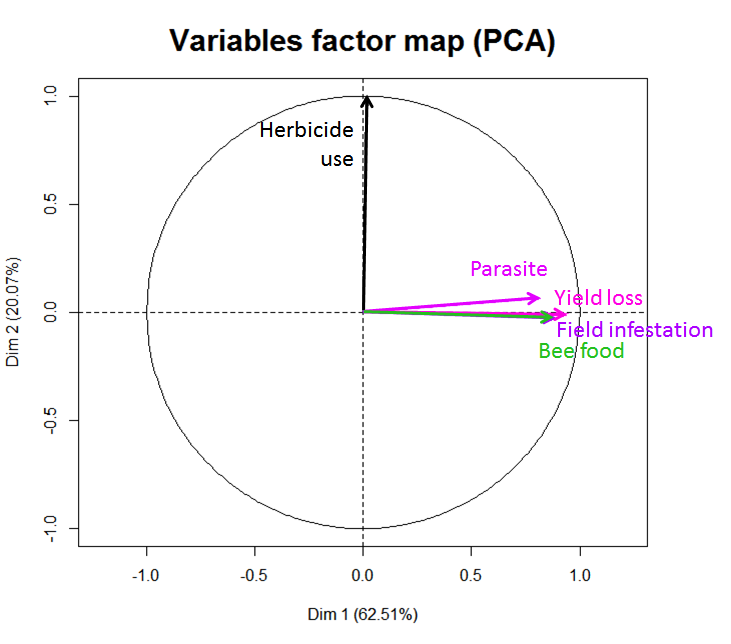


Figure 21. Synergies and antagonisms weed impact indicators. Case study with 255 cropping systems from 7 regions from France and Spain ([Colbach *et al.*, 2017c](#_ENREF_19)). Each cropping system started with the same initial weed species pool characteristic of its region of origin, was simulated over 30 years and repeated with the same 10 weather series consisting of randomly chosen weather records from its region of origin. Principal Component Analysis on weed impact indicator values per "cropping system x weather repetition", averaged over simulation for the 255 tested cropping systems. Weed benefits in green, harmfulness in purple, herbicide use intensity in black. Bee food hides field infestation

#### Aggregate indicators into a global score

Table 4. Performance thresholds for scoring individual (A) and overall (B) weed impact in the simulation study. Class thresholds were chosen to discriminate the best performance. Less stringent thresholds were used for biodiversity indicators whose maximum values were often extreme outliers, with few cropping systems achieving these results ([Colbach *et al.*, 2017c](#_ENREF_19))

|  |  |
| --- | --- |
| A. Individual weed impact score. Transformation of absolute indicator values into comparable performance classes | B. Combined, overall score |
| |  |  |  | | --- | --- | --- | | Score | Relative to maximum observed or possible value | | | Harmfulness and herbicide use | Biodiversity | | A (best) | < 5% | > 75% | | B | 5-10% | 70-75% | | C | 10-20% | 60-70% | | D | 20-30% | 50-60% | | E (worst) | > 30% | < 50% | | |  |  |  | | --- | --- | --- | | **Overall score** | **Individual scores** | | | Yield loss | Other | | **A (best)** | A | A | | **A-** | A | ≥ B | | **B** | B | B | | **B-** | B | ≥ C | | **C** | C | C | | **C-** | C | ≥ D | | **D** | D | D | | **E (worst)** | E | E | |



Figure 22. Multi-criteria evaluation with FlorSys simulations of the existing Burgundy cropping system of Table 3 (A), the same but updating the herbicide programme to currently authorized products (B), and six alternative systems using authorized herbicides and based on the guidelines of the decision tree of Figure 4 for reconciling weed harmfulness control, herbicide use reduction (with frequency treatment index on graph) and biodiversity promotion (C-G). For determination of weed impact scores, see Table 1 ([Colbach *et al.*, 2017c](#_ENREF_19))

#### Frequency analysis

Table 5 Effect of delaying wheat sowing date on blackgrass emergence (*Alopecurus myosuroides* Huds.) after sowing simulated with the monospecific prototype of FlorSys. Frequency analysis with 10 weather repetitions from Northern France and Burgundy ([based on Colbach *et al.*, 2005](#_ENREF_6))

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Delay sowing date | | Northern France | |  | Burgundy | |
| % years where weed emergence | | % years where weed emergence | |
| from | to | decreased by ≥10% | increased by ≥10% | decreased by ≥10% | increased by ≥10% |
| 3 Oct. | 10 Oct. | 7 | 7 |  | 14 | 14 |
| 10 Oct. | 17 Oct. | 7 | 0 |  | 0 | 7 |
| 17 Oct. | 24 Oct. | 7 | 7 |  | 0 | 7 |
| 24 Oct. | 31 Oct. | 14 | 7 |  | 50 | 0 |
| 31 Oct. | 7 Nov. | 57 | 0 |  | 64 | 0 |
| 7 Nov. | 14 Nov. | 50 | 0 |  | 71 | 0 |

#### What do farmers and advisors prefer?

Recently, we tested different outputs for multicriteria representation with crop advisors ([Colas *et al.*, in preparation](#_ENREF_4)). Table-based representations such as those in Figure 23.C were preferred.

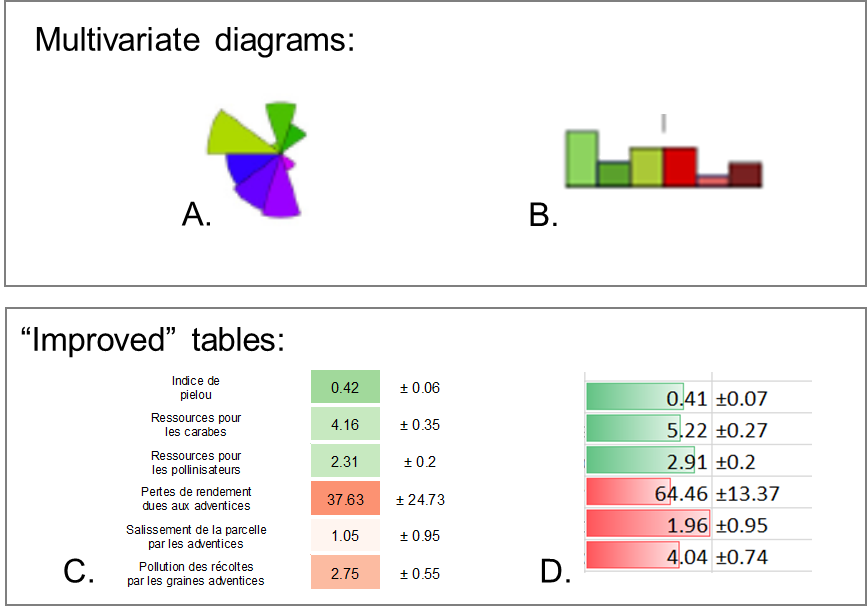


Figure 23: Different output formats that were with crop advisors ([Colas *et al.*, in preparation](#_ENREF_4))

PARTIE II – FAQ  
Foire aux questions

Frequently asked questions

Nathalie Colbach

11/26/2015

This part summarizes questions asked by users on FlorSys input files, and the corresponding answers.

# FAQ - General

## La police en majuscule ou en minuscule est-elle importante pour faire tourner le modèle ?

En général, pas sous Windows (mais il est possible qu'on ait oublié des endroits). Sous Linux/Unix oui.

## Faut-il écrire les noms des herbicides etc comme dans FlorSys

Oui, exactement la même orthographe.

## Peut-on lancer des simulations parallèles?

01/12/2015

Oui, mais il faut copier le répertoire FLORSYS; on ne peut pas lancer deux exe (FLORSYS.exe et FLORSYSwithoutWeeds.exe) depuis le même répertoire. Voir section 7.5 dans la partie manuel plus haut.

## Format des nombres

26/02/2020

Les décimales doivent être écrites en tant que xxx.xx (avec un point) et non pas comme xxx,xx (pas de virtule)

## FLORSYS me demande des fichiers \*.dll

25/03/2020

Si FlorSys bugue avec un message windows demandant des fichiers \*.dll, copier le contenue de "Parameters/dll" vers l'endroit où se trouve FLORSYS.exe.

# FAQ - Initial seed bank

26/11/2015

## How to create an initial seed bank from flora measurements

25/03/2020

* Use flora measurements from several fields and years to calculate means
* Use createInitialSeedBankFile.R in the "R scripts" directory which will calculate a "regional" seed bank where equal seed biomasses per species are weighted by the relative species density in the region
* This script will produce seedBank.dat file ready to use. Indicate the correct name in configFile.dat

Also see section 4.2.1

## The observed weed species are not in FlorSys

11/30/2021

Check whether a proxy is given in SpeciesEquivalency.par (section 4.4.4).

If not, there are two options:

* Choose a proxy from the existing FLORSYS species and indicate this in SpeciesEquivalency.par (section 4.4.4)
* Add a new species (see procedure in section 4)

# FAQ - Cropping system file inputs

## General

### - Doit-on saisir dans l'ordre chronologique ou bien par thèmes les données ?

Comme on veut. Il faut juste faire attention à ce que l'ordre soit chronologique pour une technique donnée.

### - Est-il nécessaire de mettre END à chaque fin d’ITK ou uniquement à la fin de l’ensemble des itk ?

Uniquement à la fin du fichier

## Crops

### The cultivated crop species are not in FlorSys

30/11/2021

Check whether a proxy is given in SpeciesEquivalency.par (section 4.4.4).

If not, there are two options:

* Choose a proxy from the existing FLORSYS species and indicate this in SpeciesEquivalency.par (section 4.4.4)
* Add a new species (see procedure in section 4)

## Herbicides

### Est-il nécessaire d’ajouter les adjuvants dans les Herbicides ? (même question pour les régulateurs)

il faut lister les produits commerciaux. Si il y a des adjuvants supplémentaires, on peut les lister pour avoir toutes les pratiques dans le cas où l'on veuille analyser plus en détail les pratiques. Mais cela n'aura pas d'effet supplémentaire sur les adventices dans FLORSYS.

### A quoi correspond exactement sub-optimum ?

Un agriculteur travaillant en conditions optimales aura par exemple un taux d'efficacité théorique de 100% sur un vulpin pour un anti-graminées (sur couvert peu dense). On considère que c'est le cas d'un céréalier sans bétail. Un éleveur ne pourra pas toujours intervenir dans les conditions optimales à cause de la traite et; il interviendra donc souvent dans des conditions sub-optimales. Pour un anti-graminée sur vulpin, l'efficacité théorique ne sera que de 97%. La différence sera la plus grande en cas de réduction de doses sur herbicides foliaires. En conditions optimales, il faut réduire en-dessous de 25% pour avoir une perte d'effet. En condition sub-optimale, la perte est immédiate.

### - Pour les noms des herbicides : faut-il prendre la matière active, le  nom commerciaux, le nom de référence ou n’importe quels autres noms ?

Le nom commercial. FLORSYS le remplace automatiquement par le nom de référence s'il est différent.

### - Si le nom de l’Herbicide n’apparait pas dans les paramètres, ni la matière active, est-il possible de l’ajouter ?

Oui, via herbicidesPERSO.par. Voir instructions dans HowToRunFLORSYS.docx, section 4.3.2

## Fungicides

### Les Fongicides sont-ils à détailler (silfiotham) ?

Oui, utiliser le même formalisme que pour les herbicides

Après SEED\_FUNGICIDE (ou SILTHIOFAM), ne renseigner que le fongicide traitement de semences anti-piétin-échaudage qui aura un effet dans le module piétin-échaudage

### J’obtiens le message d’erreur “you must set SILTHIOFAM, YES or NO”

…alors que j’ai renseigné le fichier d’entrée “itk.dat” correctement : j’ai effectivement écrit YES ou NO après SILTHIOFAM (ou après FUNGICIDE ou SEED\_FUNGICIDE, équivalents). Vérifier que toutes les informations requises pour les fongicides autres que le traitement anti piétin échaudage sont renseignées : date + produit commercial + dose + unité

De même lorsqu’on renseigne les insecticides, s’il manque une information la simulation s’arrête (sous Windows, « FlorsysRECORD.exe » a cessé de fonctionner)

## Crop seed loss at harvest

### Comment définir le taux de pertes à la récolte (pour les blés et betteraves) ?

Mettre zéro. C'est le taux de perte des graines de la culture qu'on met si on veut simuler les repousses de cultures. Mais ce module ne fonctionne pas encore très bien. Par exemple, il simule les repousses de culture, considérées comme adventices, dans les simulations sans adventices, ce qui fausse le calcul des pertes de rendement dues aux adventices (voir section 5.3).

## Fertilizer and manure

### Comment connaître le taux ammonium ?

(ex : solution azotée 39% - FDS Nitrate d'ammonium = 95% // pour Kémistar, NPK et ammo 27)

Le taux d'ammonium joue uniquement sur le piétin-échaudage. Nitrate d'ammonium = 50% ammonium   
Put 50% for ammonium-nitrate, 100% for pure ammonium and 75% for a mixture of both

### L’apport de Vinasse, d’Ecumes et de fumier de champignon entre dans Fertilization ou Manure ? Si c’est dans Manure, à quel type correspondent-ils ?

Updated 30/06/2022

Manure est pour des amendements organiques. Il y a deux différences par rapport à la fertilisation chimique:  
- il peut y avoir importation de semences adventices  
- il y a étalement d'une couche de matière organique à la surface du sol qui change les conditions de germination et de levée des adventices  
Pour le type, se référer aux options possibles dans InputFLORSYS.xls. Les versions de FLORSYS postérieures au 30/06/2022 acceptent des types supplémentaires de fertilisants organiques

### Apport de compost: quels types sont possibles?

30/06/2022

Les versions de FlorSys d'avant le 30/06/2022 distinguaient trois types d'apports organiques (type\_a, type\_b, type\_c) et n'acceptaient pas de compost. Les versions postérieures à cette date acceptent plus d'une dizaine de types d'apports organiques dont différents types de composts. Voir InputFLORSYS.xlsx pour les options possibles.

Attention: dans la version sans stress azoté de FlorSys, le type d'apport organique et sa teneur en azote ne jouent que pour l'effet sur l'indicateur "perte de rendement due au piétin-échaudage". Dans la vesrion avec stress azoté (les exe FLORSYS-N ou FLROSYS-Ncompetition etc), ces variables joueront sur l'ensemble du cycle des adventices et des cultures, ainsi que sur tous les indicateurs.

## Tillage and mechanical weeding

### Comment choisir les outils de travail du sol et de désherbage mécanique paramétrés dans FlorSys ?

Le tableau ci-dessous présente les outils de travail du sol et de désherbage mécanique paramétrés dans FlorSys. Dans FlorSys, les outils mélangent le sol et éclatent les mottes sur des profondeurs de 10, 20 à 30cm. Certains retournent le sol, ce qui expose les semences à la lumière et stimule leur germination. FlorSys simule également l’effet du rouleau qui n’est pas décrit dans le tableau suivant.

La vitesse et la profondeur de travail du sol de chaque outil (sauf le rouleau) doivent être renseignées dans l’itinéraire technique donné en entrée de FlorSys (itk.dat). A défaut d’information, les valeurs moyennes données dans le tableau peuvent être utilisées. Dans le cas du labour, la largeur entre 2 socs (mettre 0 pour les autres outils) et les dimensions de la rasette doivent également être renseignées. Si les dimensions de la rasette ne sont pas disponibles, indiquer 11x6 cm (largeur x hauteur). Les outils MELANGE10 et MELANGE5 sont des outils « génériques » qui mélangent le sol et éclatent le sol sur respectivement 10 et 5cm de profondeur.

Des combinaisons de ces outils sont également paramétrées dans FlorSys :

ACTISOL = CHISEL + ROULEAU + HERSEMAGNUM

VIBRO\_ROULEAU = VIBRO + ROULEAU

ROTA\_ROULEAU = ROTAVATOR + ROULEAU

CC\_ROULEAU = DISQUES + ROULEAU

HROT\_ROULEAU = HROT + ROULEAU

HALT = HERSE + HERSE (= herse alternative)

HALT\_ROULEAU = HERSE + HERSE + ROULEAU (= herse alternative + rouleau)

DECHAUMEUR\_DENTS = CHISEL + DISQUES (= déchaumeur à dents + disques)

DECHAUMEUR\_DENTS\_SOUPLES = VIBRO + DISQUES (= déchaumeur à dents souples + disques)

L'effet d'une combinaison d'outils correspond au passage des outils de la combinaison les uns après les autres, dans l'ordre dans lequel ils sont combinés. Par exemple, dans la combinaison DECHAUMEUR\_DENTS, les dents type chisel, à l'avant de l'outil, travaillent le sol en premier : elles modifient la structure du sol et arrachent des semences germées et des plantules. Puis le cover-crop, situé à l'arrière, modifie à son tour la structure du sol et arrache des semences germées et des plantules ayant survécu au chisel.



Références :

1https://tice.agroparistech.fr/coursenligne/courses/SIAFEEAGRONOMIE9cea/document/machinisme/outils/oa-tsol-charruev.htm

²https://tice.agroparistech.fr/coursenligne/courses/SIAFEEAGRONOMIE9cea/document/machinisme/outils/oa-tsol-mabecher.htm

3https://tice.agroparistech.fr/coursenligne/courses/SIAFEEAGRONOMIE9cea/document/machinisme/outils/oa-tsol-cultid.htm

4http://www.akpil.fr/tag/cultivateur/

5http://www.pastoagriculture.com/en/mounted-cultivators/chisel-europa-series/

6https://tice.agroparistech.fr/coursenligne/courses/SIAFEEAGRONOMIE9cea/document/machinisme/outils/oa-tsol-cultirot.htm

7http://www.agrobio-bretagne.org/wp-content/uploads/2010/09/houe\_rotative.pdf

8http://www.latelierpaysan.org/IMG/pdf/fiche-lpc-materiel\_houe\_rotative.pdf

9https://tice.agroparistech.fr/coursenligne/courses/SIAFEEAGRONOMIE9cea/document/machinisme/outils/oa-tsol-herserot.htm

10http://www.akpil.fr/tag/vibroculteur/

11https://tice.agroparistech.fr/coursenligne/courses/SIAFEEAGRONOMIE9cea/document/machinisme/outils/oa-tsol-pulveriseur.htm

12https://tice.agroparistech.fr/coursenligne/courses/SIAFEEAGRONOMIE9cea/document/machinisme/outils/oa-tsol-herse.htm

13http://sanslabourenbassenormandie.drupalgardens.com/sites/g/files/g755211/f/201307/panneaux%20fiches%20mat%C3%A9riel%20v3.pdf

14http://www.eco-mulch.com/info-concessionnaire-977/herse-magnum-portee.html

15https://tice.agroparistech.fr/coursenligne/courses/SIAFEEAGRONOMIE9cea/document/machinisme/outils/oa-tsol-bineuse.htm

16http://bois-choppard.com/herse-etrille-hatzenbichler-sur-paille.html

17Luc Biju-Duval, 1/09/2016

Les valeurs de vitesse, largeur entre 2 socs, profondeur de travail du sol et dimensions de la rasette sont des valeurs moyennes définies avec L. Biju-Duval, J. Caneill, N. Colbach et C. Sarrasin (2016).

## Harvest

### Quelle hauteur de coupe renseigner pour la récolte des betteraves ?

Mettre zéro. Si on veut prendre en compte aussi les mouvements de semences adventices pendant la récolte de betterave, rajouter aussi une opération de travail du sol qui est similaire au mélange de terre pendant la récolte.

### Comment gérer les récoltes (fauche) dans une culture pluri-annuelle (luzerne)?

02/12/2015

Pour simuler 3 ans de luzerne avec différentes récoltes (fauche):

* Créer un itk durant 3 ans
* seule la dernière fauche est à mettre en récolte (HARVEST), les autres sont à mettre en fauche (MOWING)

### Date de récolte trop tardive en cas d'option REPEAT

09/08/2018

Exemple de message d'erreur

The last harvest 319 2016 of the last management period 11\_MAIS listed in the cropping system file ./../L0C\_rotB/itk\_L0C.dat is too late to be followed by a repetition of the first management period 1\_BLE starting on 205 2005 (REPEAT option) 11 years later.

Ceci arrive lorsqu'on applique l'option REPEAT à un motif de rotation de base (ex. colza/blé/orge). Cette erreur est fréquente

* en cas de succession culturale relevée sur le terrain qui ne suivent pas vraiment un motif de rotation,
* lorsqu'on fait démarrer la simulation tôt (ex. 180), et fait démarrer la première PERIODE le lendemain (ex. 181) alors que la première opération n'arrive que bien plus tard (ex. 220).

Solution:

* Retarder le début de la première période 1\_BLE à 320 2005. Cela peut impliquer de retarder aussi des opérations de travail du sol ou même des dates de semis, ce qui n'est pas toujours acceptable du point de vue agronomique (ex semer un blé après une betterave récoltée en décembre ou même janvier),
* Transformer la succession en un motif de rotation plus logique

Cas particulier: début de première période en janvier ou février avec un REPEAT.

Solution: faire démarrer la première période en été ou automne, même si la première opération n'a lieu que dans l'hiver suivant.

# FAQ - Weather

26/11/2015

## I do not have complete weather files for all the years of my simulation

This is only a problem when evaluating the model, i.e. comparing simulations to independent field observations. When comparing cropping systems, simulations are usually run with randomly chosen weather series (but always the same series for all tested cropping system of a given location or region). See section 8.2 in HowToRunFLORSYS.docx

## Faut-il utliser TRUE, RANDOM ou LISTE dans configFile.dat

06/12/2015

Avec RANDOM, tu as randomisé chaque système indépendamment. Ce qu'il faut faire pour comparer des systèmes de culture (section 8.2 dans HowToRunFLORSYS.doc):

- créer un fichier meteo.dat comprenant R listes de N+1 années climatiques tirées au hasard et séparés par NEXT, avec R=nombre de répétitions, N=nombre d'années simulées. Les années sont à tirer au hasard parmi la liste d'années disponibles.

- copier ce même meteo.dat dans tous les répertoires de simulations

- indiquer LISTE dans configFile.dat, et non pas RANDOM (tire une nouvelle liste au hasard pour chaque système de culture) ni TRUE (utilise les années indiquées dans le fichier itk.dat)  
Avec RANDOM, tu risque d'avoir un tel bruit dû à la météo que tu ne vois pas l'effet système de culture ou cela peut compléter amplifier ou inverser les tendances

# FAQ - Gestion et analyses des sorties (Output)

## Quelles sorties choisir en priorité

Indicators.prn

Cropoutput est uniquement utile si on veut une description détaillée de la croissance de la culture

Synthesis.prn est nécessaire si on veut le détail de la flore adventice (espèces, stades) au cours du temps.

## Est-ce que FLORSYS calcule le rendement pour la betterave ou la pomme de terre?

02/12/2015

Non, FlorSys ne fait pas encore la partie souterraine pour l'instant.

## Comment calculer la perte de rendement due aux adventices?

26/07/2018

* Simuler le système de culture
  + deux fois, une fois avec un stock semencier rempli et une fois avec un stock vide (en s'assurant aussi qu'il n'y ait pas de fichier seedImmigration.dat qui fait entrer des semences dans la parcelle)
  + . Il faut absolument utiliser le même climat dans les deux cas, soit via l'option TRUE (les années climatiques indiquées dans le fichier itk.dat) soit LIST (les années climatiques sont celles listées dans meteo.dat).
  + Il faut activer la sortie indicators dans output.dat
* La perte de rendement est calculée comme suit:

Perte de rendement = (rdt\_avec – rdt\_sans)/rdt\_sans

Où rdt\_avec est l'indicateur *CropGrainYield(dryT/ha)* pris dans le fichier de sortie indicators.prn de la simulation avec adventices, rdt\_sans la même variable prise dans les simulations sans adventices.

Pour les autres indicateurs, on analyse les valeurs du fichier indicators.prn de la simulation avec adventices uniquement.

Le nouvel indicateur ratioWeedCropBiomass dans indicators.prn est un bon indicateur de la perte de rendement ([Colbach & Cordeau, 2018](#_ENREF_22)).

## Mauvaise performance de la luzerne

24/07/2018

Le paramétrage de la variété de luzerne GALAXY est basée sur des mesures en parcelles jardinées en vue de l'utilisation comme culture de couverture. En simulation FlorSys, elle ne pousse pas bien. Préférez donc la variété STICS paramétrée à partir de simulations avec STICS, ou ne mettez pas de variété (FlorSys met alors automatiquement la variété STICS).

## La culture de couverture n'est pas détruite avant la culture de rente

24/07/2018

A ROULEAU was used to destroy the crop but ROULEAU has no effect on emerged plants in FLORSYS. Add a MOWING operation at 0 cm height at the same date, to simulate a residue-shredding operation.

## Le fichier indicators.prn peut indiquer un rendement non nul alors que la culture n'arrive pas à maturité dans synthesis.prn et crops.prn

02/08/2018

Synthesis.prn et crops.prn indiquent ce qui se passe effectivement. Si la récolte est trop précoce par rapport à la maturité, pas de production de semences.

Indicators.prn calcule quand même un rendement, en partant de la biomasse de la culture déjà présente. Ce rendement permet de comparer malgré tout les systèmes de culture, sachant que le module de phénologie actuel peut mal fonctionner en-dehors de la latitude bourguignonne. Ce rendement sous-estime quand même le rendement qu'on aurait eu si la culture avait été à son terme.

## La culture n'a pas de biomasse à récolte dans synthesis.prn et un rendement non nul dans indicators.prn

02/08/2018

Si la culture arrive à maturation bien avant la récolte, il n'a plus aucune biomasse à la récolte dans synthesis.prn et crops.prn. Dans le fichier indicators.prn, il y aura quand même un rendement pour cette culture. En effet, synthesis.prn et crops.prn indiquent ce qui se passe effectivement. À la récolte de la culture, les plantes cultivées

## Comment trouver la raison d'une mauvaise performance observée dans indicators.prn

02/08/2018

See section 8.4 in HowToRunFLORSYS.doc

## Why is yield loss negative?

09/08/2018

Crop grain yield loss can be negative (i.e. more yield in weed-infested simulations):

1. In temporary grassland which is not supposed to produce seeds. When it does, its seed production is very low. As yield loss is calculated as *(yield in weed-free simulation – yield in weed-infested simulation)/weed in weed-free simulation*, the variation in yields due to stochasticity often lead to negative yield loss.
2. If weather events (e.g. frost) destroy most of the crop, leading to a small yield potential, i.e. yield in weed-free simulation. See previous point.
3. If management practices destroy most of the crop, leading to a small yield potential, i.e. yield in weed-free simulation. See point 1. Check whether you actually entered management practices correctly,
4. If weeds have a beneficial effect on crop growth. A rare example is maize emergence delayed by 2 days because of weeds cooling and drying the soil, with this delay protecting maize from late spring frosts.

## Les herbicides ne détruisent pas (beaucoup) les adventices

25/11/2021

Plusieurs possibilités:

* Il s'agit d'un herbicide pseudo-racinaire. Ces herbicides ne détruisent que les plantules pendant la levée. Par contre, ils persistent pendant plusieurs jours et continuent à bloquer la levée pendant les jours/semaines qui suivent l'application
* Il s'agit d'un herbicide racinaire et le système racinaire des adventices est trop profond pour que l'herbicide puisse y pénétrer. Le mode d'entrée des herbicides est renseignée dans herbicides.par (section 5.2).
* Le couvert était dense le jour du traitement. Pas assez de gouttelettes arrivent au niveau de la plante adventice (herbicide foliaire) ou au niveau du sol (herbicide racinaire ou pseudo-racinaire)

## L'efficacité des herbicides varie entre années

30/11/2021

C'est normal que l'efficacité varie, même pour un produit et un dosage donné. L'efficacité d'un traitement herbicide dépend (outre du produit, de la dose et de l'espèce adventice):

* De la densité du couvert. Plus ce couvert est dense, moins il y a de gouttelettes de produit qui arrivent au niveau de la plante adventice (herbicide foliaire) ou au niveau du sol (herbicide racinaire ou pseudo-racinaire), et moins le produit agit. Le mode d'entrée des herbicides est renseignée dans herbicides.par (section 5.2)
* De la taille des adventices: Plus elles sont grosses, plus il faut une quantité d'herbicides importantes pour les détruire (sauf pour les produits systémiques, cette info est donnée dans herbicides.par).
* Du stade des adventices: généralement, plus les plantes sont âgées, moins les produits sont efficaces. Cela dépend des produits et est renseigné dans herbicides.par.
* De la profondeur du système racinaire (dans le cas des herbicides racinaires): plus les racines sont profondes, moins l'herbicide va être efficace puisque sa conentration diminue avec la profondeur dans le sol.

## Les herbicides n'ont pas d'effet sur des plantes levées alors que le fichier herbicides.par indique une efficacité non nulle

30/11/2021

Ceci arrive pour les herbicides pseudo-racinaires qui forment une couche à la surface du sol et pénètrent dans la plante par le méristème de la pousse pendant la levée. Les plantes levees ne sont pas touches, même si les ficheirs herbicides.par (section 5.2) donnent des efficacités pour des stades post-levée.

## Le travail du sol n'impacte pas les plantes au stade germination

25/11/2021

C'est normal. Plus les plantules sont jeunes, mieux elles repiquent après arrachage, à condition que le sol soit humide. Voir le détail dans la doc FLORSYScontent, section *8.2.5 Weeding* dans *section 8.2 Tillage and mechanical weeding*

## La récolte n'a pas d'impact sur les adventices

25/11/2021

La fauche et la récolte ne détruisent les adventices que si elles ont commencé à fleurir et surtout à produire des semences. Avant, une telle opération détruit de la biomasse. Les plantes peuvent ensuite mourir pendant les jours suivants si elles n'ont pas assez de réserves pour repartir.

# FAQ - Quelles préconisations pour améliorer les systèmes de culture: Que faire si…

Attention: ne jamais oublier qu'un problème observé en année N peut être dû à un évènement en année N-X.

## …la culture n'est pas mûre lors de la récolte? …la culture mûrit longtemps avant la récolte?

02/08/2018

Ne pas changer les dates de semis

Ne pas préconiser non plus de changement de dates de récolte aux agriculteurs puisque le problème est non seulement très lié au module phénologique dans FLORSYS mais aussi à la variété. Les agriculteurs savent comment optimiser leur date de récolte. Il faut uniquement préconiser des changements de dates si cela permet de mieux maîtriser la flore.

Ce n'est pas la compétition avec les adventices qui empêche une culture de mûrir (sauf si elle meurt).

## … la culture de couverture est semée dans la flore résiduelle du précédent?

02/08/2018

Un travail du sol ou un broyage (MOWING hauteur 0 cm) entre la récolte et le semis

Réduire la hauteur de coupe de la récolte 🡪 effet broyage

## …des adventices grainent en culture de couverture?

02/08/2018

Si ces adventices peuvent aussi potentiellement infester des cultures de rente:

* Vérifier que le couvert lève bien
* Rendre le couvert plus étouffant en changeant sa composition ou en augmentant la densité de semis
* Empêcher leur grenaison en détruisant le couvert plus tôt

## … la luzerne est semée dans un champ sale et permet la grenaison des adventices?

02/08/2018

Si semis dans un champ sale, le problème est avant et il faut trouver, si possible, des solutions avant.

Solutions avant le semis: faux semis + labour pour enfouir les semences, choisir une variété de luzerne compétitrice (pas GALAXY)

Solutions une fois que le semis est fait: faucher plus fréquemment pour empêcher les adventices de grainer et les faire mourir. Attention: la fauche détruit les adventices surtout si elles ont commencé à fleurir. Avant, elles sont tout à fait de capable de repartir et produire beaucoup de semences. Elles ne dépériront que si elles sont ombrées par des voisines.

## …des adventices grainent dans une culture étouffante?

02/08/2018

Si des adventices grainent dans une culture mais ont une faible biomasse et ne causent pas de perte de rendement, elles produisent probablement aussi peu de semences. Si c'est le cas, probablement pas besoin d'opération supplémentaire. Sinon, désherbage chimique ou mécanique pour viser spécifiquement ces adventices (difficile d'être précise ici sans plus d'informations), et/ou travail du sol (faux semis et/ou labour) après la récolte pour éliminer les graines fraichement produites.

# FAQ – paramétrage

## C'est quoi les ndj\_vegetatif[X]?

Pour la plupart des espèces, le temps de la levée d'une plante pour atteindre la floraison dépend de quand la plante lève, à cause de l'effet photopériode. Dans FlorSys, le temps de la levée au début de la floraison est la somme de ndj\_cotyledon + nd\_plantule + ndj\_vegetatif[X]. ndj\_cotyledon et nd\_plantule sont des constantes pour une espèce donnée, étant respectivement la durée du stade cotylédon et du stade plantule, en degrés-jours.

La durée du stade végétatif (en degrés-jours) ndj\_vegetatif[X] dépend du mois X pendant lequel la plante atteint le stade végétatif. Par exemple, pour une espèce automnale, ndj\_vegetatif[X] est le plus long pour les mois X du début de l'automne et diminue jusqu'aux X de printemps. Ensuite, ndj\_vegetatif[X] peut devenir infini pour certains mois X, indiquant que la plante ne va jamais fleurir si elle atteint le stade végétatif trop tard.

Exemple du vulpin (ALOMY)



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Appendix 1. STICS input variables for soil

|  |  |
| --- | --- |
| argi | teneur en argile de la couche de surface [%] |
| Norg | teneur massique en azote organique dans l'horizon d'humification (de la surface du sol à profhum) [0.05%-0.3%] |
| profhum | profondeur équivalente d'humification entre la profondeur de labour et 60cm [cm] |
| calc | teneur en calcaire dans la couche de surface [%] |
| pH |  |
| concseuil | concentration minimale du sol en NH4 |
| albedo | albédo du sol nu à l'état sec (SD) |
| q0 | limite d'évaporation de la phase potentielle d'évaporation du sol [mm] |
| ruisolnu | fraction de la pluie ruisselée (par rapport à la pluie totale) en conditions de sol nu |
| obstarac | limitation de l'enracinement par la profondeur du sol [cm] (pour info, profondeur maximale simulable = 10m) |
|  |  |
| capiljour | remontées capillaires [mm/j] |
| humcapil | humidité minimale pour activation remontées capillaires [geau/gsol] |
| profimper | profondeur de l'imperméable [cm] |
| ecartdrain | écartement entre drains [cm] |
| ksol | conductivité hydraulique à saturation pour le transport de l'eau vers les drains [cm/j] |
| profdrain | profondeur des drains [cm] |

|  |  |
| --- | --- |
| Pour différents horizons | |
| epc | épaisseur de l'horizon [cm] : |
| HCCF | humidité à la capacité au champ de la terre fine des horizons [geau/gsol] |
| HMINF | humidité minimale exploitable par la plante de la terre fine des horizons [geau/gsol] |
| DAF | densité apparente de la terre fine des horizons |
| cailloux | teneur volumique en cailloux des horizons [%] |
| typecailloux | 1 = calcaires B1 (non-porous limestone) |
|  | 2 = calcaires B2 (porous limestone) |
|  | 3 = calcaires L (lutetian semi-porous limestone) |
|  | 4 = caillasses L (lutetian stones) |
|  | 5 = graviers m (morainic gravel) |
|  | 6 = silex (silex, sandstone or unaltered granite) |
|  | 7 = granits a (altered granite) |
|  | 8 = calcaires J (rendzinic porous calcareous) |
|  | 9 = autre 1 |
|  | 10 = autre 2 |
| infil | infiltrabilité à la base de chaque horizon [mm/j] |
| epd | épaisseur de chaque couche de la microporosité [cm] : mieux vaut entrer 1... |

1. après avoir sélectionné l'ensemble des données (attention aux lignes vides qui peuvent limiter le filtrage au premier bloc de données) [↑](#footnote-ref-1)
2. Normalement, les vérifications des fichiers d'entrée par FlorSys devraient maintenant détecter une opération listée dans une PERIODE mais dont la date ne rentre pas dans la durée de la PERIODE. Si il y a par exemple une erreur dans l'année de l'opération, il est possible que FlorSys n'exécute pas cette opération. [↑](#footnote-ref-2)