User manual

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Contents

1. Overview

The CoHort software is an executable program available in French and English and freely downloadable on your computer. It was created and tested as part of Solène Pissonnier's PhD thesis, conducted jointly within the Plantes et Systèmes de Culture Horticoles (PSH, Inra-Avignon) and UMR Innovation (CIRAD/Inra/SupAgro) research units, and funded by the ANR Sustain'Apple project. Based on an analysis of the practices and strategies of apple producers in two French cooperatives (Pissonnier et al., 2016), CoHort aims to support horticultural producers in their reflections regarding the technical, economic and environmental evolution of their farms and practices (Pissonnier et al., 2017). It can also be used by researchers to design innovative configurations of horticultural systems, particularly in the context of agro-ecological transition (Pissonnier et al., 2019), or in the context of initial and professional training.

CoHort is part of **a strategic support approach** conducted by an adviser with an individual producer or a group of producers. The approach is based on the design and simulation of different scenarios, each representing a possible evolution of the case studied. CoHort calculates the performance of the simulated scenario at the environmental (TFI - Treatment Frequency Index), labour (monthly supply-demand balance) and economic (gross and net margins) levels. Analysing scenario outputs and comparing scenarios allow producers to better evaluate *ex-ante* the advantages and disadvantages of each configuration that is explored. This brain-storming support may eventually lead to a decision, which may include maintaining the *status quo* if the changes envisaged do not prove to be relevant with regard to the producer's objectives.

CoHort represents the farm by breaking it down into three components (Figure 1):

(i) farming activities to be modelled, which will be described precisely in terms of crop blocks, cropping practices per block and labour required;
(ii) farming activities for which only labour requirements will be taken into account;
(iii) off-farm activities that are also time consuming[1].

CoHort includes three modules (see sections 5, 6 & 7). The first one, called 'Parameters', allows users to create their own lists of names **in their own language[2]** regarding:

. farming and off-farm activities;
. cultivars per crop;
. crop operations;
. treatment product families and individual products;
. labour categories;
. expenses (fixed and variable).

These lists are generally specific to an intervention area and will be used with all cases studied in that area. They are completed by the software user as new items are encountered.

The second module, called 'Farm', allows the user to create a farm and briefly describe its cropping pattern and livestock.

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[1] Off-farm activities correspond to non-farming tasks conducted by farmers and their families either on or out of the farm.
[2] Only the fixed titles of CoHort are necessarily in French and English.

The third module, called 'Scenario', allows the creation and characterisation of each scenario related to the farm under study. For this, a set of pages must be filled in concerning the farm's:

(i) labour resources;
(ii) labour requirements of the non-modelled part of the farm;
(iii) fixed costs.

Then, after further breaking down the modelled part of the farm into crop blocks, the following information must be entered for each block:
a. surface area, crop cultivated on it, cultivar concerned and yield;
b. selling prices of the productions;
c. related farming practices and labour monthly labour requirements;
d. treatments carried out;
e. variable costs.

The results calculated include the TFI per block and over the entire farm, monthly labour balance, costs per task and block, gross margins per block and total, and net margin on the modelled part of the farm. **All variables and equations used in CoHort are described in Appendix A.**

Scenarios can be very diverse, ranging from changes in practices requiring investments, such as the use of nets in orchards or the introduction of new cultivars more resistant to fungal diseases (Pissonnier et al., 2017), to the redesign of the entire production system, such as the introduction of a sheep herd in a specialised apple farm (Pissonnier et al., 2019).

Figure 1. CoHort conceptual model
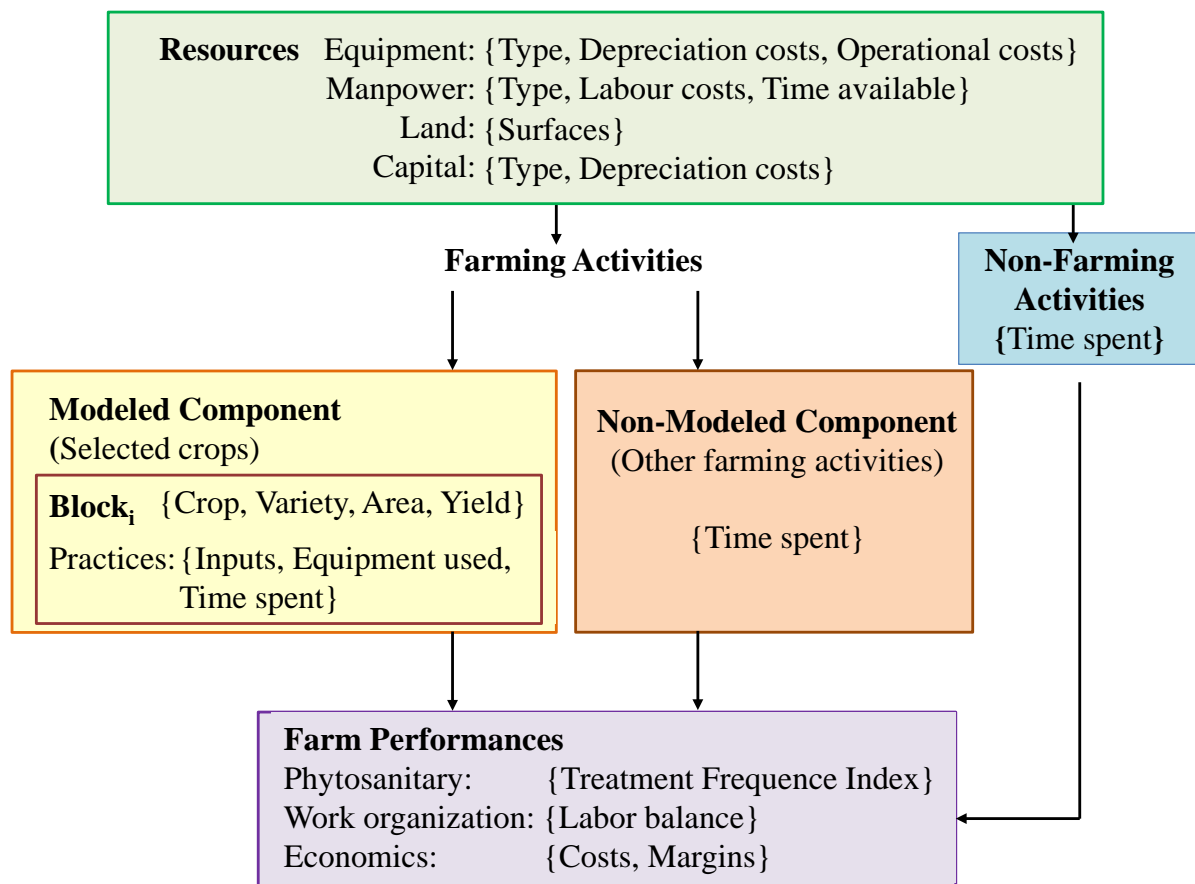
For more information :

Pissonnier S., Lavigne C., Toubon J.-F., Le Gal P.-Y., 2016**.** Factors driving growers' selection and implementation of an apple crop protection strategy at the farm level. *Crop Protection* 88, 109-117. http://dx.doi.org/10.1016/j.cropro.2016.06.007

Pissonnier S., Lavigne C., Le Gal P.-Y., 2017. A simulation tool to support the design of crop management strategies in fruit tree farms. Application to the reduction of pesticide use. *Computers and Electronics in Agriculture* 142(A), 260–272. http://dx.doi.org/10.1016/j.compag.2017.09.002

Pissonnier, S., Dufils, A., Le Gal, P.-Y., 2019. A methodology for redesigning agroecological radical production systems at the farm level. *Agricultural Systems* 173, 161–171*.* https://doi.org/10.1016/j.agsy.2019.02.018

2. Licence

CoHort is freely available at the following link:

https://www6.paca.inrae.fr/psh/Modeles-et-logiciels/Cohort

It is available to professionals working in the horticultural sector, including agricultural consultants, under a BSD-3-Clause license.

3. Software installation

Download the archive by clicking on the link above, open the archive and run the setup.exe file. A subdirectory called CoHort 2019 is then created in your Programs directory.

 A second subdirectory called CoHort is also created in your 'My Documents' directory. It stores a set of information related to your own use of the software (e.g., parameter values).

You can finally create your own CoHort directory to store the *.csv files resulting from the export of each scenario you wish to keep.

4. Welcome page

The Welcome page allows you to select the working language (English or French) by clicking on the two dedicated buttons at the top right of the screen.

Then click on 'Démarrer' (if French has been selected) or 'Start' (if English has been selected) to go into the software.

Select language

Enter the program

Once in the program, the screen displays a grey banner with the three modules 'Parameters', 'Farm' and 'Scenario' which allow access to all of CoHort's functions (see screen shot on the following page). In addition, the 'Save' and 'Export' functions are activated when a new farm or scenario is created, or when a change is made in farms and scenarios which already have been created.

This banner appears on every CoHort screen. The scroll-down menus of each module can be displayed by clicking on their names at any time.

5. Parameters

When using CoHort for the first time, **the values of the Parameters variables have to be entered first**, as they will then be used in the two other modules through various choice lists. These values can be enriched throughout the use of the software when new occurrences are encountered while characterising new farms and scenarios.

As indicated in the general presentation, the 'Parameters' module has seven pages that must be filled in.

5.1. Activities

Four types of pre-determined activities are proposed: crop (crop names: apple, pear, apricot, etc.), livestock (name of the domestic species, specifying their production if necessary: dairy cattle, beef cattle, meat sheep, etc.), other farming activity, and off-farm activity.

The user first chooses the type of activity and then enters a new name in the 'Activity name' field. Then he/she clicks on "Add" and the value is entered in the corresponding table.

It is possible to "Modify" and "Delete" the occurrences already entered. The user first clicks on the selected occurrence, which is highlighted. By clicking on "Modify", the occurrence appears in the "Activity name" where it can be modified and added. By clicking on "Delete", it disappears.

These three buttons "Add", "Modify" and "Delete" are found on all of the screens of the software.

5.2. Cultivars

A set of cultivars can be entered for each crop entered on the previous page. The user starts by choosing a crop from the list constructed in 5.1. The selected crop is displayed with the cultivar names already entered. Then he/she enters the name of a new cultivar in the dedicated field.
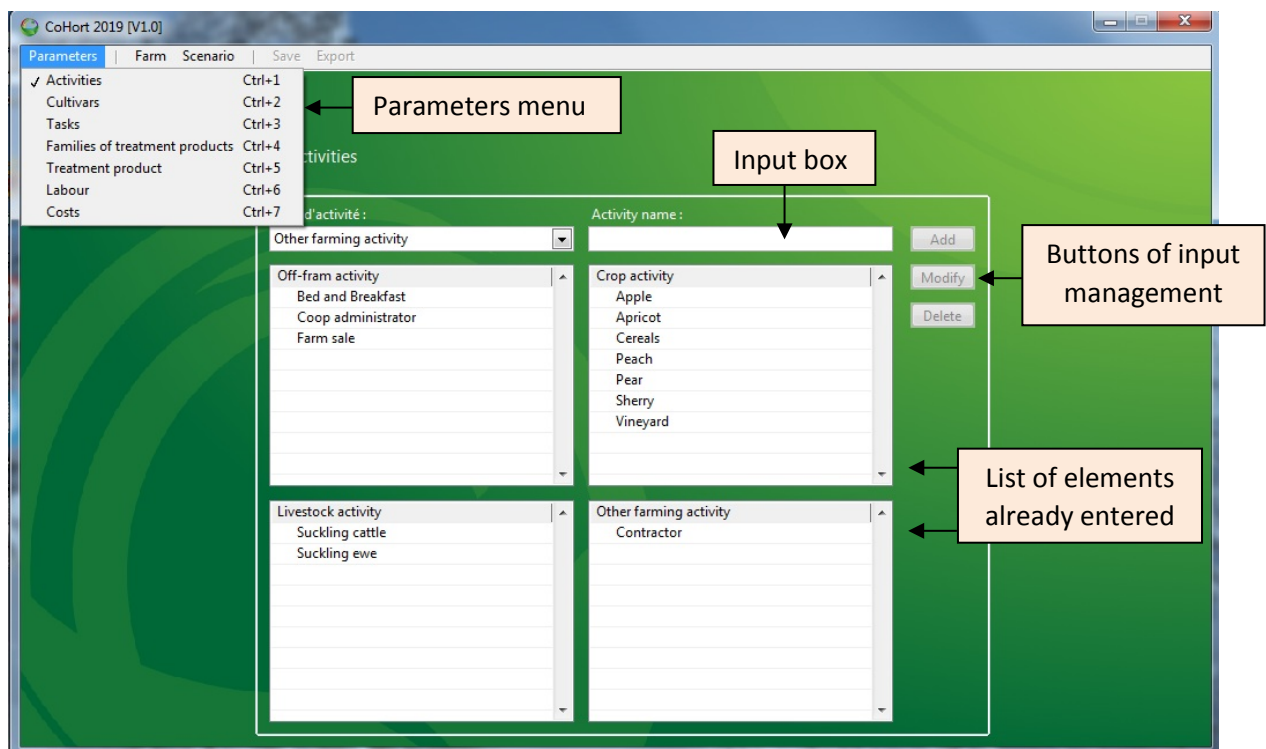
5.3. Tasks

The names of tasks that require labour, equipment and inputs are entered on this page according to their nature: crop, livestock, other. The names already entered appear in the three dedicated tables. To enter a new name, the user first selects the kind of task, then enters the name itself in the 'Task name' field.
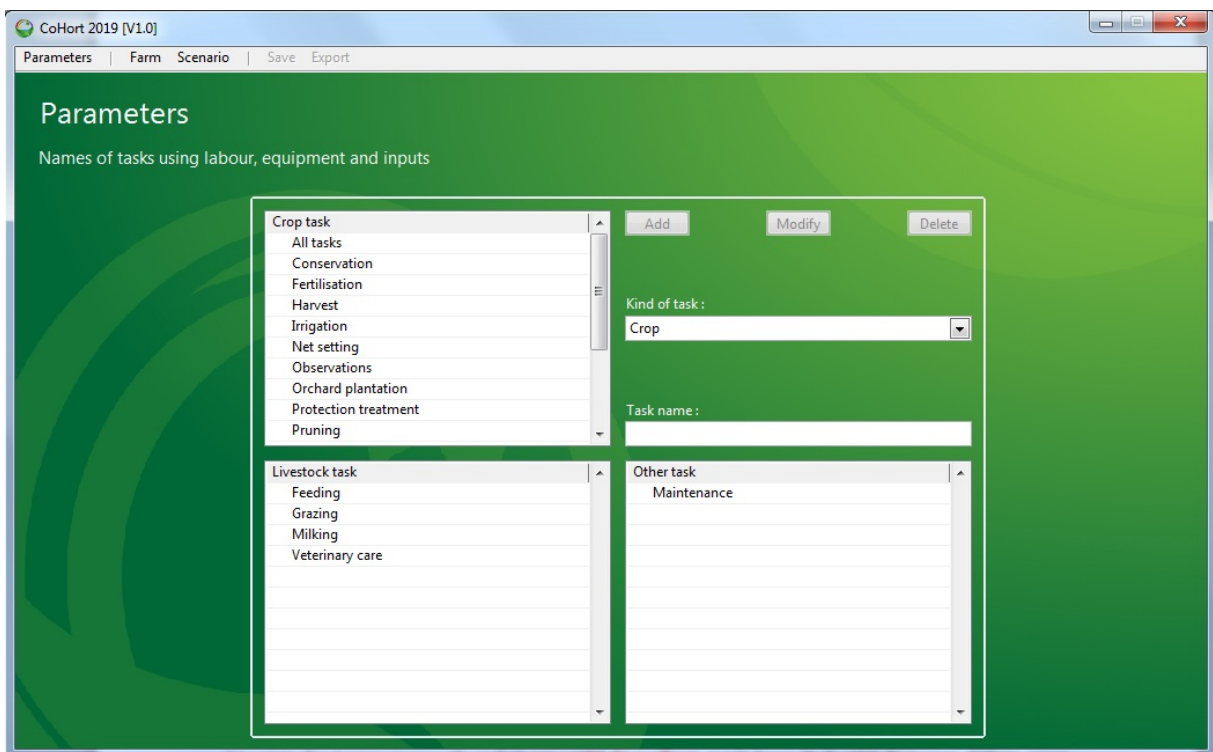
5.4. Families of treatment products

In order to facilitate data entry and analysis, it is possible to work with treatment product families and/or with individual products themselves in CoHort.

The 'Treatment product families' page allows the user to enter these family names, which are then used to define, if necessary, the product names per family (section 5.5), and to calculate the Treatment Frequency Indexes (section 7.6.1).

> **Warning!** Only the product families included in the TFI calculation are concerned by this table.
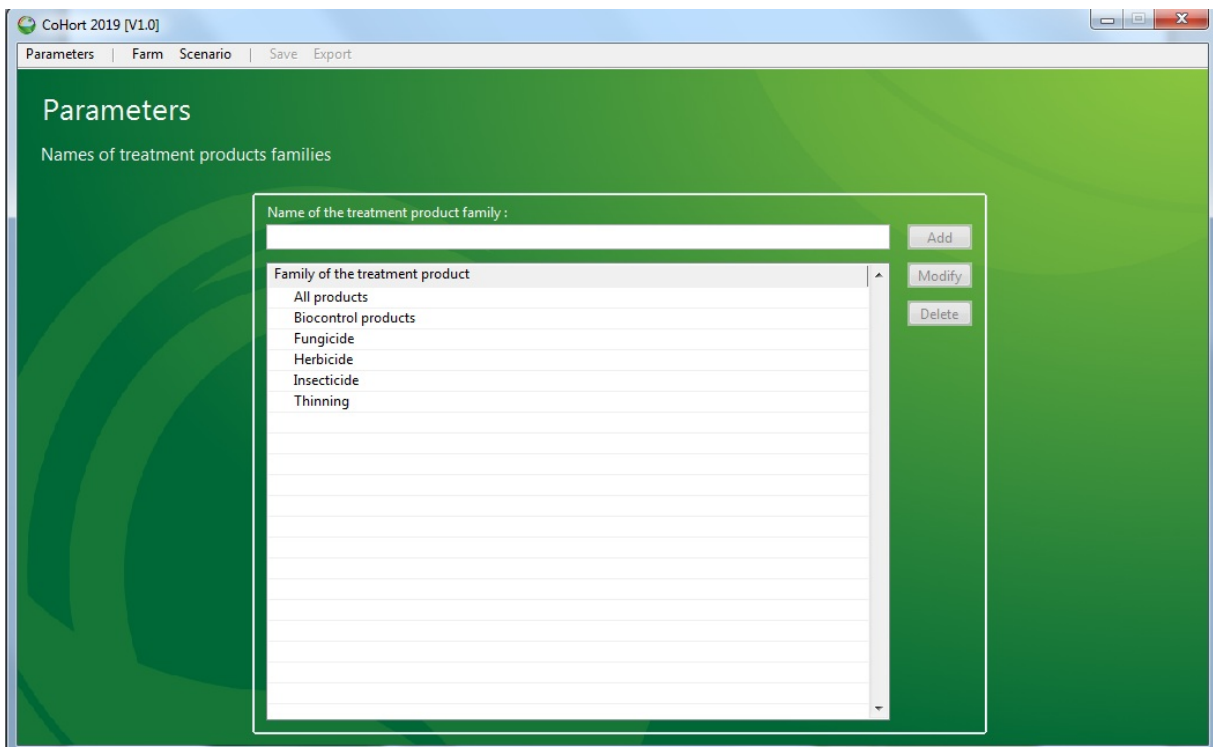
5.5. Treatment products

CoHort allows all of the treatment products per family used in the working area of the software user to be listed. Each new product is defined by entering its commercial name and its unit cost.

> **Warning!** If the user wishes to be able to work only on the product families, **he/she must also enter their names here a second time** so that he/she can choose them when defining the treatments by block in the 'Product choice' field (section 7.5.3). The unit cost entered is then an average cost **per treatment** calculated on all of the products belonging to the family considered, as well as the associated dose entered in section 7.5.3. Another solution is to enter a cost per hectare **per treatment** with an associated dose of 1.

> **Warning! The cost per unit does not refer to a monetary unit, nor to a volume unit.** This choice is deliberate as it gives the software greater flexibility in terms of context of use. It is systematically applied for all of the quantitative variables requiring a unit encountered in CoHort.
>
> On the other hand, it supposes that the user is consistent at all points of the software for the same object. For example, the cost calculation of a treatment product consists in multiplying the dose used on a crop block by the block surface, then by its unit cost. If the cost of the treatment is expressed in €/ha, the surface area of the blocks (entered in section 7.5.1) should be in ha, the unit cost (entered in section 5.5) in €/liter, and the dose (entered in section 7.5.3) in liter/ha.
>
> If many units are used according to the products and productions listed, **it may be useful to report in a separate file the different units used** according to the products and productions, i.e., area, input volume, production weight, currency.

> **Warning!** Only products whose use is included in the TFI calculation are concerned by this table.

Parameters

Names of treatment products

Selection of product family :	Product name :	Cost per unit :	
Insecticide		0	Add

Family of the treatment product	Treatment product	Cost per unit		
Insecticide	Acakill	2,31	▲	Modify
Insecticide	Calypso	188,35		
Insecticide	Insecticide	0		Delete
Insecticide	Suprême	137,43		

5.6. Labour

This page allows the categories of labour that can be found on farms in the user's area to be defined. Each category is defined by its name and unit cost.

The choice was made to consider this cost as constant for a category of labour in a given context, and thus to integrate it in the 'Parameters' module. The user can nevertheless adjust the amounts by creating new categories corresponding to the real cases encountered. The example provided below takes into account two possible situations: the one where the farm head and the family workforce are paid, with the salaries being charged to expenses, and the one where they are not (payment on the net margin).

> **Warning !** As in the previous case, **the time unit is not predefined** and must therefore be chosen and maintained throughout the software by the user. In the case of working time, it can be, for example, hour, day or month. **This choice then applies to all categories of labour** and may require intermediate calculations to be made outside the software to go from a unit mentioned by the producer to the one taken into account in the application.
>
> For example, if seasonal labour is paid by the hour and permanent labor is paid by the month, the hourly cost of the latter must be recalculated to have the same unit as the former.

5.7. Costs

Four types of costs are predefined in CoHort: fixed, variable for crops, variable for livestock, and other variable costs. The user enters the names of the cost items that he/she will need in scenarios by first choosing the nature of the cost from among these four types, and then by entering the name of the cost item. This name is then entered in the list corresponding to the type of cost chosen.
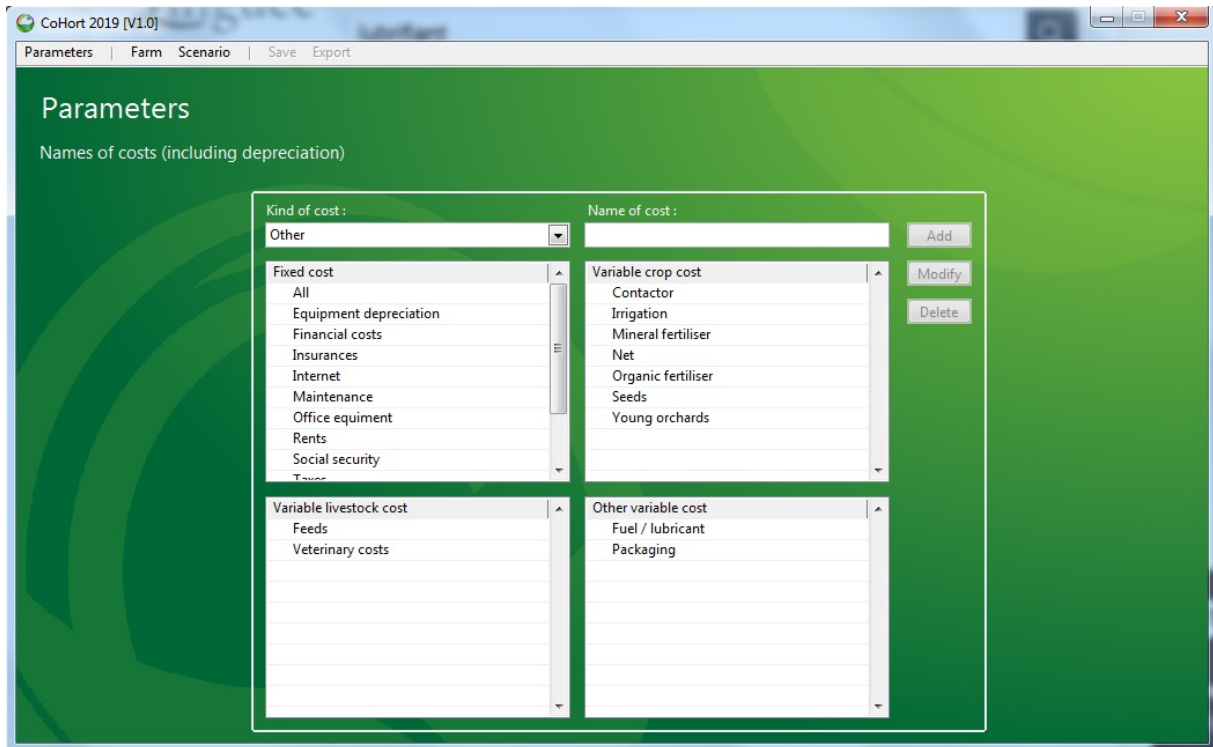
6. Farm

Nota bene: the example used to illustrate the manual is a fictional farm.

6.1. Selection of the farm studied

Whether real or virtual, each new farm with which the user has to work must first be created. To do this, enter the farm name in the dedicated field. The "Create" and "Rename" buttons are then activated. By clicking on the "Create" button, the name is entered in the list below with the date that the farm was created.

To rename a farm that already has been created, simply select it from the list and type the new name in the dedicated field, then click on the "Rename" button.

To work on a farm, whether newly created or renamed, click on the "Open" button. The name of the farm and its creation date are then displayed at the top of the page. These two pieces of information will then appear on all pages related to the farm.

It is possible to delete a created farm by selecting it from the list and clicking on the "Delete" button. This action, as well as opening a created farm, triggers a message alerting the user to the risk of data loss.

Display of the selected farm name and of the date it was entered in CoHort
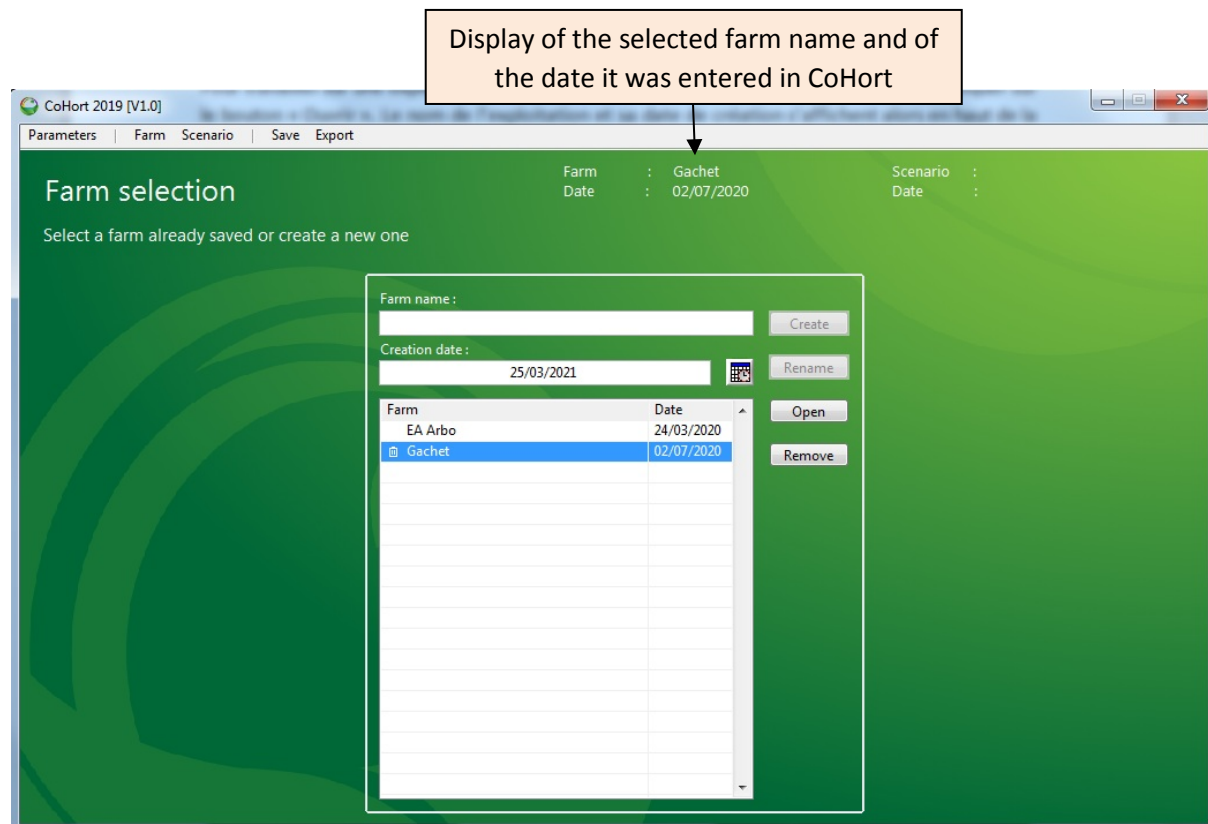
6.2. Farm features

This page gathers information that is not used in the subsequent calculations, but that allows the user to keep a brief description of the farm studied, to which he/she can return during the course of the work to verify certain entries related to the scenarios: total surface area, permanent labour force, initial cropping pattern and livestock, marketing mode.

The values in the upper box are to be entered with the keyboard, while the choices of crop and livestock activities are made from the lists defined in the 'Parameters' module.

7. Scenario

The 'Scenario' tab provides access to the scenario 'Selection', and to its characterisation with regard to 'Labour supply', 'Labour demand outside blocks' and 'Fixed costs', and to the 'Block' and 'Results' submenus.
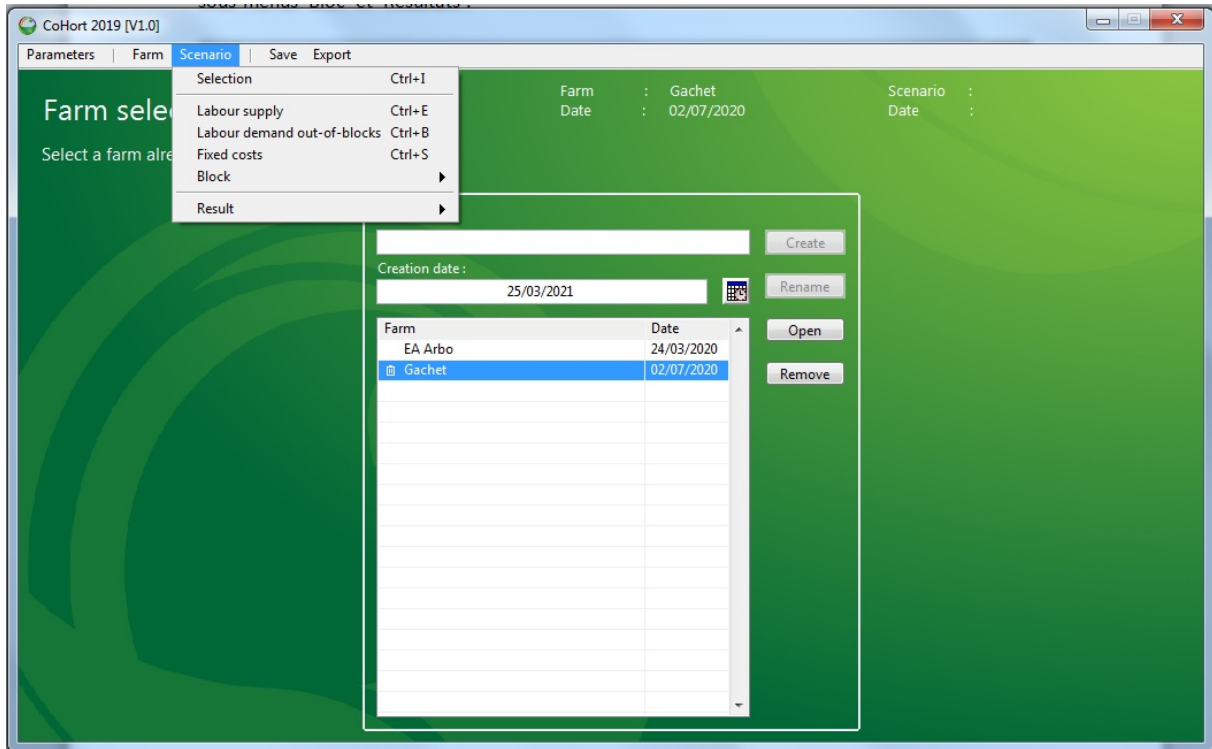
Nota bene: the scenario used to illustrate the manual is fictious.

7.1. Selection of the scenario studied

Each farm can be the subject of an infinite number of scenarios. To create a scenario, go to the "Scenario name" field and type in the name you have chosen. The two buttons "Create" and "Rename" are activated. By clicking on "Create", the scenario name is entered in the list below.

To rename an already created scenario, click on the scenario name which is then highlighted, then type the new name in the dedicated field and click on the "Rename" button which has been activated. A message appears asking you to confirm the procedure. If the procedure is confirmed, the new name will appear in the list of created scenarios.

To work on a scenario, you must open it by clicking on its name in the list (it is then highlighted) and then clicking on the "Open" button. Its name is then displayed on the top left of the page. It will appear in all the following pages corresponding to the characterisation and the results of the calculations specific to this scenario. This display allows the user to make sure that he/she is on the desired scenario.

A scenario can be deleted using the same procedure, but by clicking on the "Delete" button instead of "Open". In both cases, warning messages appear on the screen to prevent the unintentional loss of entered data.

This selection stage is necessary before moving to the next stages (7.2 to 7.6).

Display of the selected scenario and the date it was created in CoHort
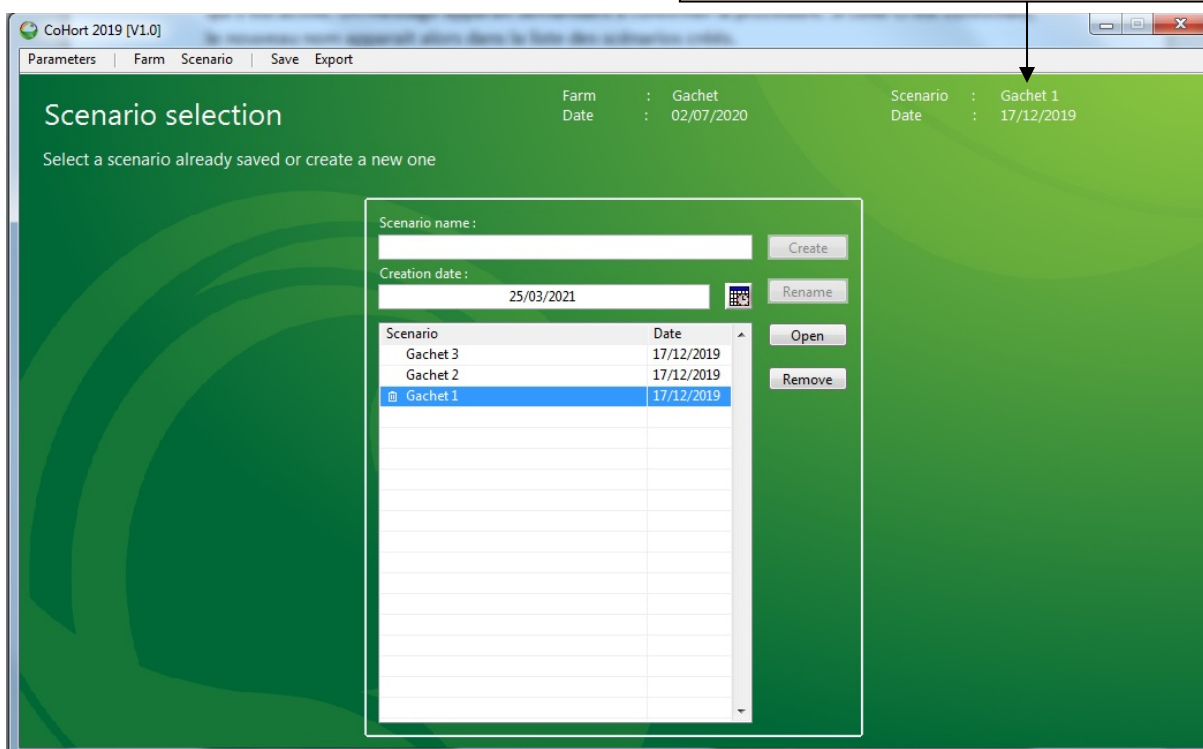
7.2. Labour supply

The labour balance calculated by CoHort requires the user to first list the resources available on the farm. This description is done person by person, by attaching each person to one of the labour categories defined in 'Parameters'. For each person, the user provides the amount of working time available per month, employing the time unit used to define the unit labour costs (section 5.6). Once the person is created, times are entered directly in the cells of the table.

Warning! Seasonal labour is a special case when it appears in a scenario. It is not included in the calculation of the labour supply-demand balance (section 7.6.2), which only concerns the farm's permanent labour force. However, it is taken into account in the labour requirements of the modelled part of the farm (section 7.5.4) in order to include its cost in the calculation of variable costs and then gross and net margins. To enter these requirements, the following steps must be taken:

(i) Enter this seasonal labour category in the 'Parameters' module (section 5.6);

(ii) Enter it as a person in section 7.2 'Labour supply' by setting the available time to zero over the 12 months (see example below);

(iii) If necessary, select this category and this person in the characterisation of labour demand by block by specifying the task and the amount of time required (section 7.5.4).

The monthly values are entered directly into the cells of the table as in a spreadsheet. When the first value is entered, the software asks if the user wishes it to be duplicated for the 12 months of the year. This procedure speeds up data input. However, each monthly value can be modified by clicking directly on the cell.

The "Modify" button only affects the category and the name of the person already entered.
The "Delete" button deletes the person and his/her values.
The "Clear all" button clears the whole table (persons and values).

CoHort 2019 [V1.0]

Parameters | Farm Scenario | Save Export

Farm : Gachet Scenario : Gachet 1
Date : 02/07/2020 Date : 17/12/2019

Monthly working availabilities of permanent labour (seasonal labour may be mentioned without any availability)

Selection of permanent labour : Worker name :

Family without salary ▼

Add Modify Delete Clear all
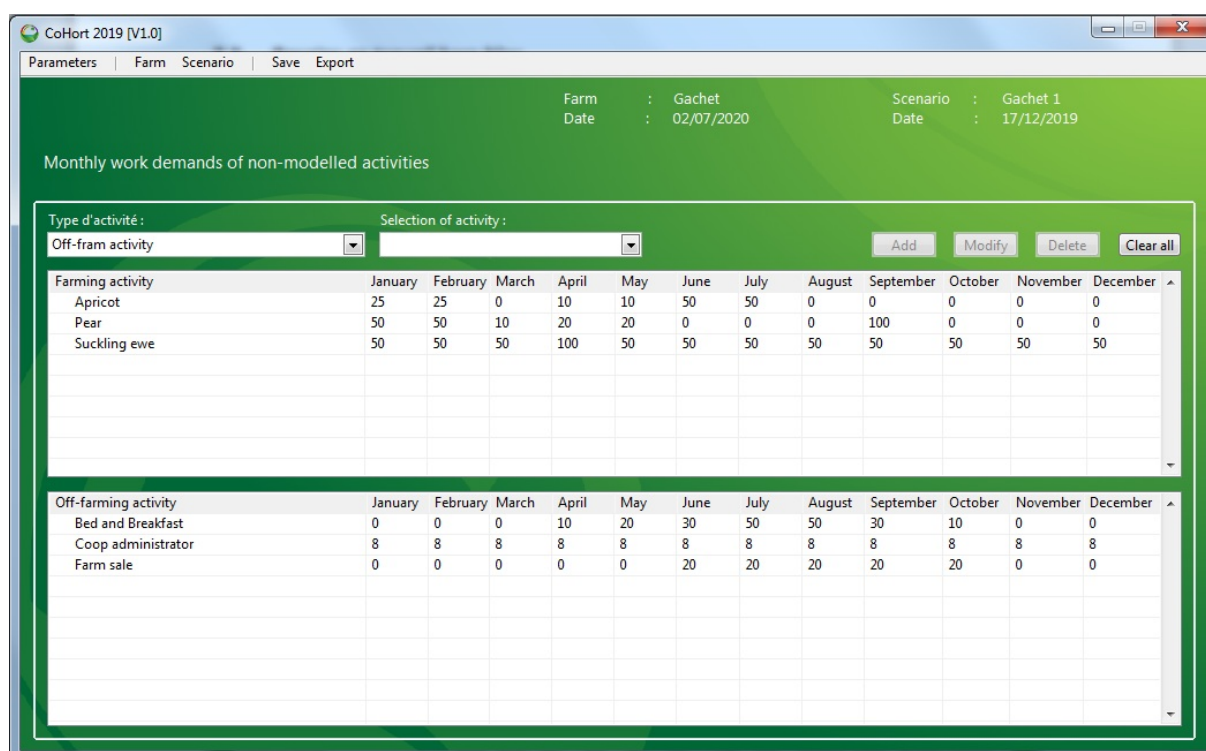
Kind of labour	Involved worker	January	February	March	April	May	June	July	August	September	October	November	December
Family without salary	Pierre	50	50	0	0	0	0	0	0	0	0	50	50
Farm head without salary	Florence	160	160	160	160	160	160	160	160	160	160	160	160
Permanent staff	François	160	160	160	160	160	160	160	160	160	160	160	160
Temporary staff	Temporary staff	0	0	0	0	0	0	0	0	0	0	0	0

7.3. Labour demand of non modelled activities

Labour is the only resource for which a balance sheet is made at the farm level and not only on the modelled part (section 7.6.2). To do so, the user must enter here the aggregated monthly labour requirements (all persons and labour categories combined) for each non-modelled activity.

These activities are chosen among those defined in the 'Parameters' module: farming (crop, livestock, other) and off-farm.

As before, the monthly values are entered directly into the cells of the table.

7.4. Fixed costs

CoHort makes it possible to include the fixed costs, i.e., those that cannot be attributed to a particular activity or production (e.g., depreciation of equipment used in several activities, financial costs, etc.) in the calculation of the economic results **regarding the modelled part of the farm**. The net margin generated by this part can thus be estimated in addition to the gross margin, which only integrates the variable costs (section 7.6.4).

To do this, the user selects the cost items that concern the farm studied from those listed in the 'Parameters' module ('Selection of fixed cost'), and then enters for each selected item (i) its cost per unit area (the one that will be used for block size) and (ii) the proportion of this cost assigned to the modelled part of the farm.

7.5.   Block

The definition and characterisation of the blocks concern **only the modelled part of the farm**, which they constitute.

The "Block" submenu gathers together the following information for each block: its characterisation, sales of its production, phytosanitary treatments carried out, tasks conducted and associated labour requirements, and the variable costs related to them.
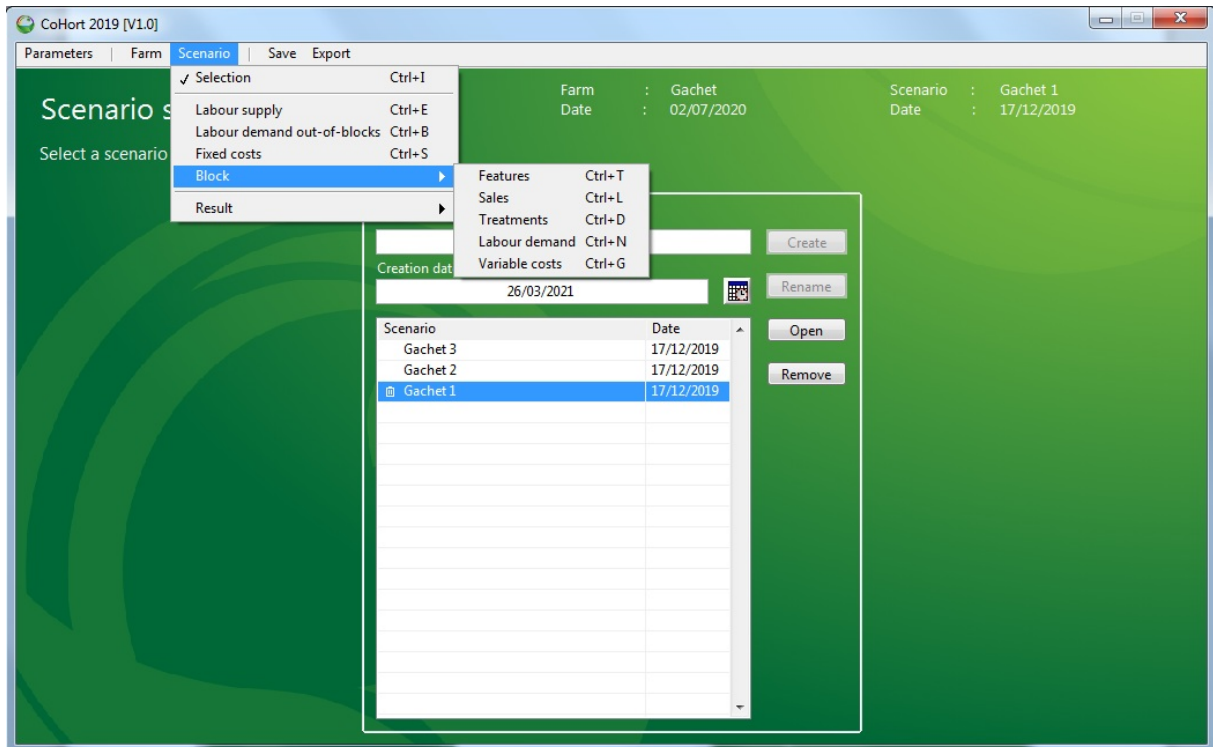
7.5.1. Features

The user first defines the blocks that constitute the modelled part of the farm. Each block corresponds to a physical plot or a set of identically managed plots. It may be tempting to multiply blocks, or even to "stick" to the plot reality of the farm, but this mechanically increases the amount of data to be entered. The user must therefore work with the producer to find a compromise based on the data and time available to carry out the simulations, and on the configuration of the scenarios envisaged.

A block is defined by its name, the crop selected among those listed in 'Parameters' (5.1), the cultivar linked to the chosen crop (5.2), its area and its yield. These last two variables must be consistent in terms of units with those used elsewhere in the software since CoHort does not predefine any units.

> **Warning!** If the user wishes to change the name of a block when he/she already has entered a certain amount of data describing it in the following pages, all of these data will be lost. A message warns of this risk. **It is therefore preferable to stick to the names defined at this stage**.

> **Warning!** The yields entered are those corresponding to the practices described in the following pages (treatments, labour and variable charges). In general, they are not derived from cultivation models but from expert references or estimates (producers, technicians, researchers, etc.). **The user must therefore consider the possible consequences of these changes on the yields entered each time these practices are modified**, in order to maintain the overall consistency of the scenario.

7.5.2. Sales

Each block's production can be sold at different prices depending on its quality. The user therefore specifies here (i) the selling price per unit of volume and (ii) the proportion of the production sold at this unit price.

> **Warning!** When opening this page and the following ones, all of the fields are empty. If blocks have already been created and information entered, simply select them by making the list appear in the "Block Name" field. The values corresponding to the selected block name, and only these, will then appear in the table below.
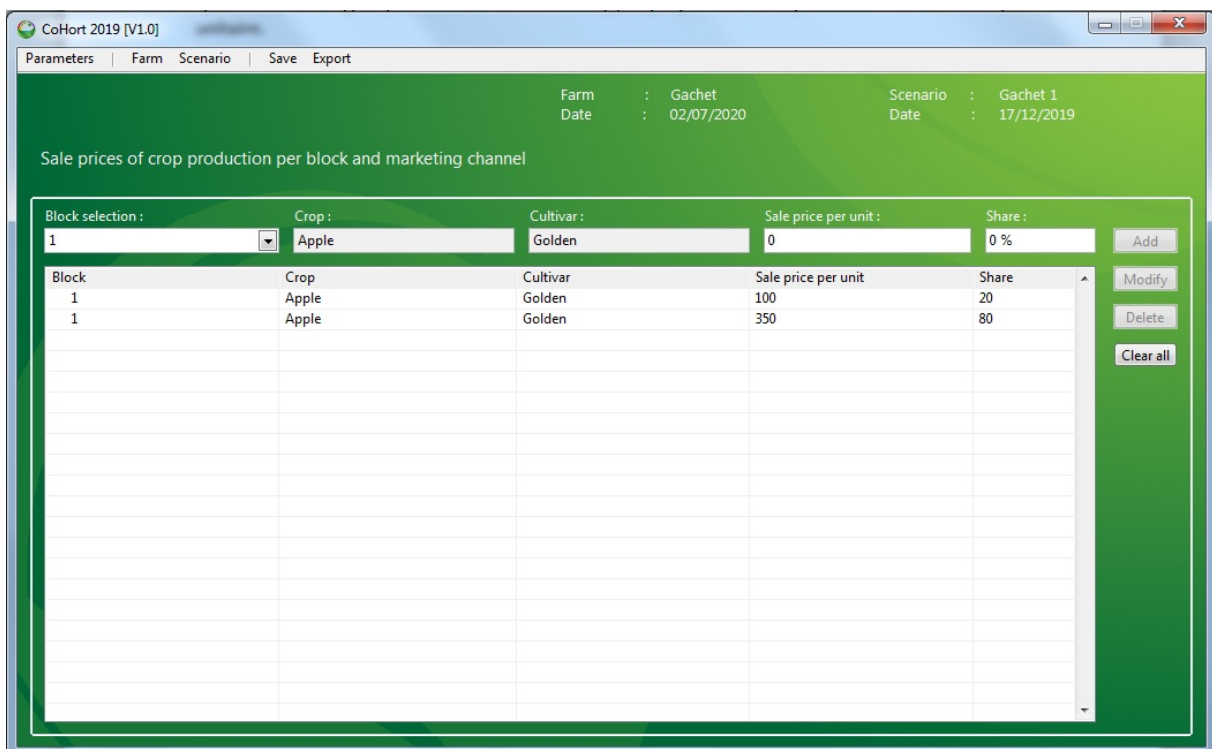
7.5.3. Treatments

The description of the phytosanitary treatments carried out on each block constitutes one of the essential components of CoHort, which initially was designed to reproduce treatment strategies on a farm scale.

Each phytosanitary intervention (i) is positioned in a block, (ii) is linked to a crop operation, (iii) belongs to a product family, (iv) is made up of a product, (v) which can be applied several times a year (number of treatments), (vi) at a dose whose unit of volume must correspond to that of the unit price defined in the 'Parameters' module (5.5) and whose unit of area must correspond to that of the blocks (7.5.1).

In order to calculate the only environmental indicator contained in CoHort, namely the TFI, the user enters the % TFI corresponding to each treatment. If the producer has applied the approved dose for the use of the product on the crop in question, this proportion is equal to 100. A dose that is x% lower (e.g., for herbicides) or an application area that is x% smaller reduces this proportion by the same amount (e.g., a half-dose or half the area results in a % TFI of 50).

If the user does not wish to go down to the product but only to the product family, he/she must enter the names of the families in the list of products defined in 5.5. so that they appear in the "Product choice" field. The number of treatments then corresponds to the number of applications of the family in question, regardless of the products used. See 5.5 for the values to be entered for the unit cost and the dose corresponding to each family.

The calculation of the TFI is done at a minimum by block and by product family (7.6.1).

> **Warning!** When the user works only by product family, **it is preferable to respect the spelling of the family name** as entered in 5.4.

> **Warning!** Only products and product families whose use is included in the TFI calculation are concerned by this table.

7.5.4. Labour demand

Labour requirements are entered (i) by block, (ii) by task, then (iii) by category of labour and (iv) by person concerned within that category.

Monthly time is entered **by area unit**, based on the time unit defined for resources (see 7.2) and the area unit defined for blocks (7.5.1).

The comparison of these individualised needs with the individualised resources allows the calculation of balances per person within the farm **for the part that is modelled** (see 7.6.2).

7.5.5. Variable costs

Variable costs are entered (i) by block, (ii) according to the nature of the task (crop, livestock, other) and (iii) the task itself. They are defined by (i) the nature of the cost and (ii) the name of the cost (5.7). The unit cost is given **per unit area** and is based on the monetary and area units previously used by the user.

> **Warning!** Crop protection costs are not included in this page as they are calculated from the data entered in 7.5.3. The same applies to labour costs which are calculated from the data entered in section 7.5.4.

The costs entered here can be aggregated by task (e.g., total expenditure on fertilisers for the 'Fertilisation' task) or individualised (e.g., cost of fertiliser 1, cost of fertiliser 2, fuel, etc.), depending on the user's wishes. However, when this is the case, the user must define precisely in the cost names what he/she wants to appear in the choice lists (5.7). The calculation of the economic results stops at the 'Task' level (see 7.6.3).

7.6. Results

The 'Result' submenu of the 'Scenario' menu includes the calculation of the TFI, labour balances, costs per task and economic results.

7.6.1. Treatment Frequency Index

The TFI is first calculated per block from the list of treatments entered in 7.5.3 (see equation in Appendix A). The total value obtained is then divided by the block production in order to get a simple evaluation of the efficiency of the treatments.

The total TFI is then broken down into the different product families defined in 5.4.

Finally, an average TFI for the farm is calculated by weighting the values per block by the area of the blocks.

	1	2	3	4
Crop	Apple	Apple	Apricot	Pear
Cultivar	Golden	Pink Lady	Roussillon	Comice
TFI	7,0	14,0	4,0	2,0
TFI per unit of production	0,16	0,40	0,40	0,13
TFI per product family	----------------	----------------	----------------	----------------
All products	0,0	0,0	0,0	0,0
Biocontrol products	0,0	0,0	0,0	0,0
Conservation	0,0	0,0	0,0	0,0
Fertilisers	0,0	0,0	0,0	0,0
Fungicide	4,0	10,0	0,0	0,0
Herbicide	1,0	0,0	0,0	0,0
Insecticide	2,0	4,0	4,0	2,0
Oils	0,0	0,0	0,0	0,0
Others	0,0	0,0	0,0	0,0
Thinning	0,0	0,0	0,0	0,0

Mean IFT on the farm: 8,5

7.6.2. Labour balance

CoHort calculates three types of monthly labour supply-demand balances in total number of time units (see equations in Appendix A). A positive value indicates an excess of labour (underemployment), a negative value a deficit requiring a correction (reduction of demand or employment of additional labour, permanent or seasonal) which can be the subject of a new scenario.

. By labour category

CoHort calculates the monthly labour balance by labour category **on the modelled part of the farm**, based on the requirements entered by crop block (section 7.5.4). The table shows all of the labour categories defined in 5.6, even if they were not used in the scenario studied.

The screenshot shows the CoHort 2019 [V1.0] interface with the following data:

Farm: Gachet **Date:** 02/07/2020 **Scenario:** Gachet 1 **Date:** 17/12/2019

Calculation of the balances between supply and demand of work

Tabs: Monthly balance per kind of labour (modelled part) | Monthly balance per permanent staff (modelled part) | Monthly and annual balance at farm level

Monthly balance:

	January	February	March	April	May	June	July	August	September	October	November	December
Family with salary	0	0	0	0	0	0	0	0	0	0	0	0
Family without salary	-14	-14	0	0	0	0	0	0	0	0	50	-14
Farm head with salary	0	0	0	0	0	0	0	0	0	0	0	0
Farm head without salary	160	122	21	59	80	80	160	160	160	160	160	160
Permanent staff	16	16	122	122	160	99	160	160	160	160	160	16

Monthly demand:

	January	February	March	April	May	June	July	August	September	October	November	December
Family with salary	0	0	0	0	0	0	0	0	0	0	0	0
Family without salary	64	64	0	0	0	0	0	0	0	0	0	64
Farm head with salary	0	0	0	0	0	0	0	0	0	0	0	0
Farm head without salary	0	38	139	101	80	80	0	0	0	0	0	0
Permanent staff	144	144	38	38	0	61	0	0	0	0	0	144

Monthly supply:

	January	February	March	April	May	June	July	August	September	October	November	December
Family with salary	0	0	0	0	0	0	0	0	0	0	0	0
Family without salary	50	50	0	0	0	0	0	0	0	0	50	50
Farm head with salary	0	0	0	0	0	0	0	0	0	0	0	0
Farm head without salary	160	160	160	160	160	160	160	160	160	160	160	160
Permanent staff	160	160	160	160	160	160	160	160	160	160	160	160
Temporary staff	0	0	0	0	0	0	0	0	0	0	0	0

. By active worker

On the same basis as the preceding balance (**modelled part of the farm**), this balance sheet gives an individual view of the monthly workload.

This table includes the values calculated for seasonal labour already present in the previous table since this labour appears as both a category and a person (see 7.2).

CoHort 2019 [V1.0]

Parameters | Farm Scenario | Save Export

Farm : Gachet Scenario : Gachet 1
Date : 02/07/2020 Date : 17/12/2019

Calculation of the balances between supply and demand of work

| Monthly balance per kind of labour (modelled part) | | | | Monthly balance per permanent staff (modelled part) | | | | | Monthly and annual balance at farm level | | | |

Monthly balance :

	January	February	March	April	May	June	July	August	September	October	November	December
Florence	160	122	21	59	80	80	160	160	160	160	160	160
François	16	16	122	122	160	99	160	160	160	160	160	16
Pierre	-14	-14	0	0	0	0	0	0	0	0	50	-14
Temporary staff	-76	-76	0	0	0	-30	-30	0	-152	-278	-186	-76

Monthly demand :

	January	February	March	April	May	June	July	August	September	October	November	December
Florence	0	38	139	101	80	80	0	0	0	0	0	0
François	144	144	38	38	0	61	0	0	0	0	0	144
Pierre	64	64	0	0	0	0	0	0	0	0	0	64
Temporary staff	76	76	0	0	0	30	30	0	152	278	186	76

Monthly supply :

Worker	January	February	March	April	May	June	July	August	September	October	November	December
Pierre	50	50	0	0	0	0	0	0	0	0	50	50
Florence	160	160	160	160	160	160	160	160	160	160	160	160
François	160	160	160	160	160	160	160	160	160	160	160	160
Temporary staff	0	0	0	0	0	0	0	0	0	0	0	0

. On the whole farm

This balance sheet integrates the non-modelled activities of the farm (outside the blocks). It therefore aggregates all labour categories (including seasonal) and provides an overall assessment of the monthly and annual workload.

This balance sheet is useful to identify possible labour surpluses or deficits linked to the combination of the modelled part of the farm with other labour-generating activities. On this basis, a discussion can be initiated with the producer to modify one and/or the other of these two farm sub-components.

For example, a labour deficit can be absorbed by increasing the working time of the permanent workforce, by employing additional permanent staff, or by using seasonal labour on the non-modelled part of the farm. The latter solution may already be used in practice by the producer. However, it is not explicitly taken into account in the scenario since the labour demands of the non-modelled part are not divided between labour categories to simplify data collection and entry.

CoHort 2019 [V1.0]

Parameters | Farm Scenario | Save Export

Farm : Gachet	Scenario : Gachet 1	
Date : 02/07/2020	Date : 17/12/2019	

Calculation of the balances between supply and demand of work

Monthly balance per kind of labour (modelled part)	Monthly balance per permanent staff (modelled part)	Monthly and annual balance at farm level

Whole farm balance :

Total	January	February	March	April	May	June	July	August	September	October	November	December
471	-47	-85	75	33	132	-9	112	192	-40	-46	126	28

Whole farm demand :

Total	January	February	March	April	May	June	July	August	September	October	November	December
3569	417	455	245	287	188	329	208	128	360	366	244	342

Demand on the modelled part :

Total	January	February	March	April	May	June	July	August	September	October	November	December
2103	284	322	177	139	80	171	30	0	152	278	186	284

Supply of the whole permanent staff :

Total	January	February	March	April	May	June	July	August	September	October	November	December
4040	370	370	320	320	320	320	320	320	320	320	370	370

7.6.3. Costs per task

The costs per task are calculated per block and for the whole farm, in monetary units per unit area.

For each task, (i) treatment costs (section 7.5.3), (ii) labour costs (section 7.5.4), and (iii) variable costs (section 7.5.5) are summed together.

Calculation of variable costs per area unit for each task (block and whole farm)

	Whole farm	1	2	3	4
Crop	-	Apple	Apple	Apricot	Pear
Cultivar	-	Golden	Pink Lady	Roussillon	Comice
Task	---------------	---------------	---------------	---------------	---------------
Fertilisation	11	20	10	0	0
Harvest	799	1040	780	780	390
Protection treatment	120	112	66	137	241
Pruning	859	780	900	900	900
Soil preparation	3	10	0	0	0
Thinning	83	240	0	0	0
Weeding	130	341	20	20	15

7.6.4. Economic results

The economic results are calculated per block, per crop and on the modelled part of the farm. They systematically include gross products and variable costs, plus fixed costs for the farm.

. By block

The presentation by block details the expenses by distinguishing between labour, the costs of phytosanitary treatments and the other variable costs. The gross margin is calculated by subtracting these three cost items from the gross product.

. By crop and cultivar

Gross margin is only presented in these tables, by crop and cultivar. Calculations are made by area unit.

*. On the whole farm (**modelled part only**)*

This table takes the same items as for each block and adds the fixed costs attributed to the modelled part of the farm (7.4), which makes it possible to calculate a net margin for this part. The calculations are made per unit area and in total once the area of each block is taken into account.

Inside the screenshot:

CoHort 2019 [V1.0]

Parameters | Farm Scenario | Save Export

Farm : Gachet   Scenario : Gachet 1
Date : 02/07/2020   Date : 17/12/2019

Calculation of economic results per block and for the modelled part of the fram

Results per area unit for each block	Mean gross margin per area unit for each crop and variety	Results for the modelled part of the fram

	Per area unit	Total
Gross product	6776	74540
Labour	1844	20284
Treatment products	128	1403
Other variable costs	33	366
Total of variable costs	2005	22053
Gross margin	4772	52487
Fixed costs	56	616
Net margin	4716	51871

8. Save

Any changes made to a farm or scenario can be saved by clicking on the "Save" button on the top banner. An additional box appears, where the "Save" button is only activated if changes have been made since the last save.

In addition, if the user wishes to duplicate the data of the farm or scenario, he/she places himself/herself in the fields "Farm name" or "Scenario name" respectively and types in the new name for this duplication. The "Duplicate" button is then activated and creates the new farm or scenario. This function is particularly useful to start from an existing scenario and then modify it, while keeping the original version of the scenario.

If changes have not been saved before leaving CoHort, a reminder message appears on the screen.
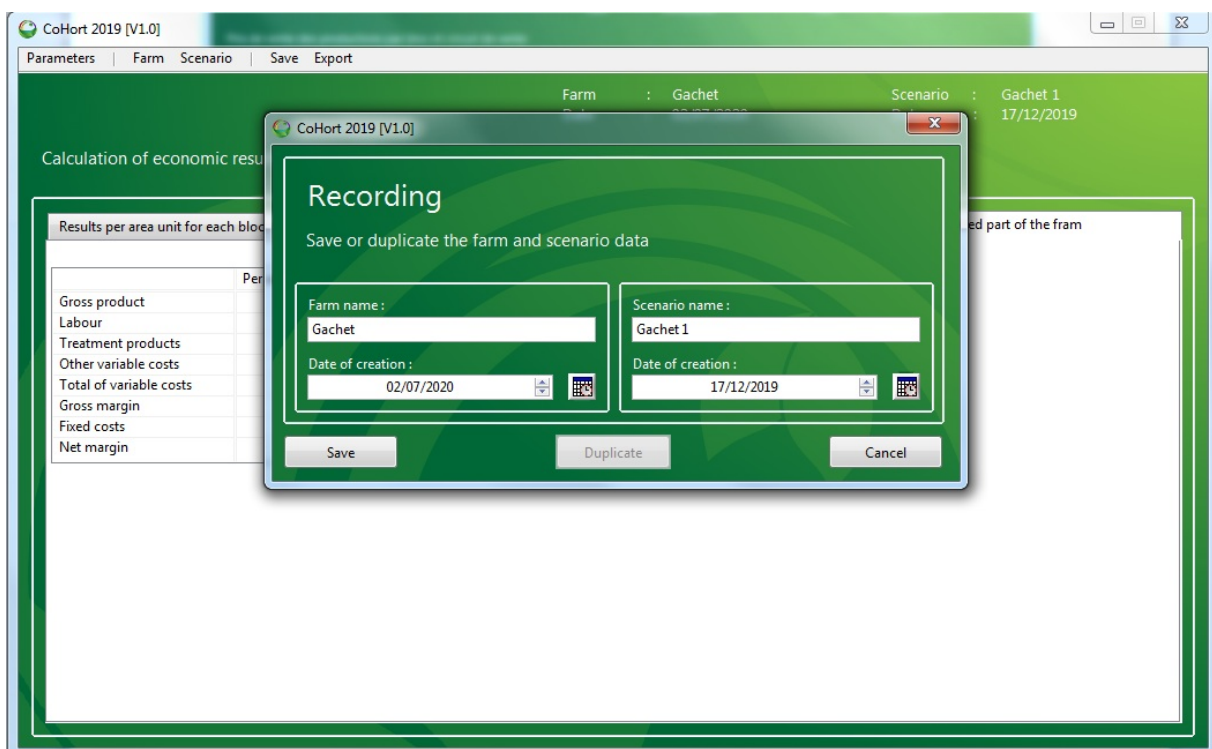
9. Export

CoHort offers the possibility of exporting the values entered for all of the input and output variables of a scenario in the form of .csv files that can be recovered in a spreadsheet program such as Excel®.

By clicking on the "Export" button located on the top banner, the software proposes to save the work done in one of the directories on the user's hard disk. A subdirectory is then created where all of the files describing the scenario concerned are stored.

The user can then manage this data in a spreadsheet or word processor to produce graphs or tables, for example comparing different scenarios. These materials can then be used for discussions with the producer, illustrate analysis reports or be used in training sessions, for example.
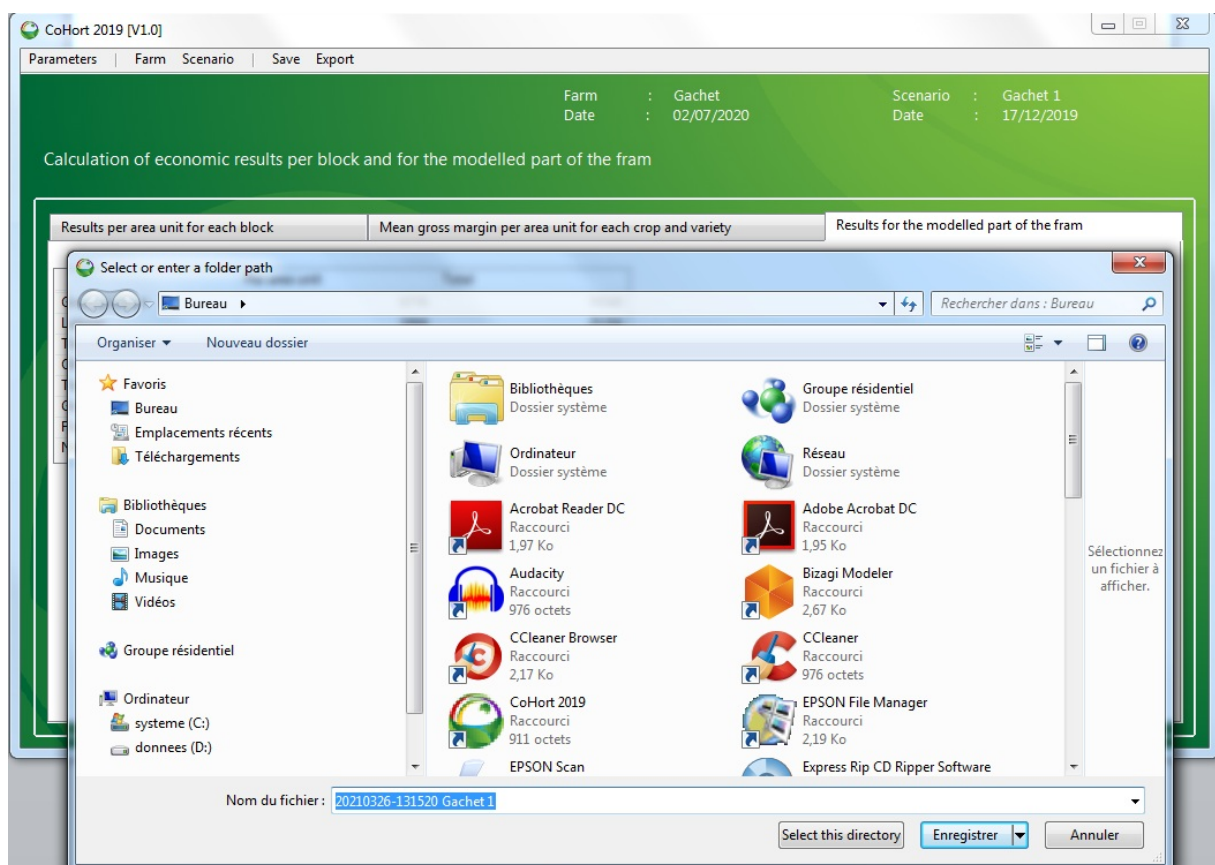
Appendix A. List of variables and equations included in CoHort

Nota-bene: Index and variable names are the same as used in the French version of the manual.

A.1. Index list

act = activity
cult = crop
i = block
j = category of selling price for a given production
chf = fixed cost
chv = variable cost
e = permanent staff
fprod = family of treatment product for crop protection
m = month
p = practice
prod = treatment product (synthetic and natural) for crop protection
mo = category of labour
var = cultivar

A.2. Unit definition

CoHort does not specify any unit in order to keep the calculations as flexible as possible. But in return the user must always use the same unit for all variables that depend on it. For example, a unit price given in euros per kg should be multiplied by a production quantity in kg/ha to obtain a gross product in euros per hectare.

Unit	Signification
UProd	Quantity unit per treatment product (l, kg, bag, etc.)
UM	Monetary unit (€, $, £, etc.)
UP	Weight unit per production (kg, ton, bag, etc.)
UT	Time unit (h, day, month, etc.)

A.3. Colour codes of variables

The only 'Parameter' variable used in calculations is in red.

The input variables used in calculations are in black.

The variables corresponding to intermediate calculations between input variables and results are in bold brown in equations (see their calculation mode in the dedicated tables).

« Final » output variables are in bold black.

Output variables reused in other calculations are in bold blue.

Nota bene 1: in all tables, the variables are classified by alphabetic order.

Nota bene 2: the variables names used in the French version have been kept in the English one.

A.4. Input variables 'Parameters'				
Variable	**Definition**	**Unit**	**Object**	**Range**
CuProd$_{fprod,prod}$	Cost per unit of treatment product *prod* or family of product *fprod*	UM/UProd	Treatment product	[0 ; +∞[
Fam$_{fprod}$	Name of the family of product *fprod*	Text	Treatment product	-
Nom$_{fprod,prod}$	Name of the treatment product *prod* belonging to the family of product *fprod*	Text	Treatment product	-
Nom$_{cult}$	Name of crop *cult*	Text	Crop	-
Nom$_{act}$	Name of off-farm activity *act*	Text	Off-farm activities	-
Nom$_{cult,var}$	Name of cultivar *var* per crop *cult*	Text	Crop	-
Nom$_p$	Name of practices	Text	Practices	-
Nom$_{mo}$	Name of labour category *mo*	Text	Labour	-
Nom$_{ch}$	Name of fixed (*chf*) and variable (*chv*) cost	Text	Costs	-

Reminder:

✓ The "Parameters" variables are variables indicated by the user at the beginning of the simulation when he/her first starts. They take values reusable in a set of farms *via* selection lists in the scenarios definition. Most of them are text variables (names) whose values are found in the index of input variables, except for the variable CuProd$_{fprod,prod}$ reused in calculation.

✓ The user completes these lists as and when he/she encounters new values. The software automatically classifies these values from A to Z in these lists so that they can be more easily used in the choice menus linked to input variables.

A.5. Input variables 'Scenario'				
Variable	**Definition**	**Unit**	**Object**	**Range**
%IFT$_{i,p,fprod,prod}$	Proportion of the TFI retained according to the applied dose of the product *prod* per ha or the product family *fprod* for the practice *p* on the block *i* (%)	-	Block	[1 ; 100]
%PV$_{i,j}$	Proportion of the production sold at price PV$_{i,j}$	-	Bloc	[1 ; 100]
%CHF$_{chf}$	Proportion of annual fixed costs *chf* allocated to the modelled part of the farm	-	Exploitation	[1 ; 100]
CCHF$_{chf}$	Annual amount of fixed cost *chf* per ha	UM/ha/year	Farm	[0 ; +∞[
CCHV$_{i,p,chv}$	Amount per hectare of variable cost *chv*, for practice *p* other than phytosanitary treatment on block *i*	UM/ha	Block	[0 ; +∞[
CuMO$_{mo}$	Unit cost for labour category *mo*	UM/UT	Farm	[0 ; +∞[
DAct$_{m,act}$	Labour demand for non-modelled farming and off-farming activity *act* selected in the 'Crop', Livestock', 'Other' & 'off-farm' activity lists for month *m*	UT	Farm	[0 ; +∞[
DispMO$_{m,mo,e}$	Labour supply of permanent staff *e* on the whole farm (modelled and non-modelled) for month *m*	UT	Farm	[0 ; +∞[
DT$_{i,p,mo,e,m}$	Labour demand per hectare for practice *p*, category of labour *mo* and permanent staff *e* on block *i*	UT/ha	Block	[0 ; +∞[
NbTrt$_{i,p,fprod, prod}$	Number of treatments of product *prod* and product family *fprod* for practice *p* on block *i*	-	Block	[0 ; +∞[
Nom_Bloc$_i$	Name of block *i* characterised within the modelled part of the farm	Text	Block	-
Nom_Culture$_i$	Crop *cult* for block *i*	'Crop' list	Block	-
Nom$_e$	Name of permanent staff *e* (including the farm head)	Text	Farm	-
Nom_Variété$_i$	Cultivar *var* for block *i*	'Cultivar per crop' list	Block	-
PV$_{i,j}$	Selling price of the production for category of price *j* on block *i*	UM/UP	Block	[0 ; +∞[
Q$_{i,p,fprod,prod}$	Quantity of product *prod* par ha or family of product *fprod* for practice *p* on block *i*	UProd/ha	Block	[0 ; +∞[
Rdt$_i$	Yield of block *i*	UP/ha	Block	[0 ; +∞[
S$_i$	Area of block *i*	ha	Block	[0 ; +∞[

	A.6. Intermediate calculations variables (invisible in the software)				
Variable	**Definition**	**Unit**	**Object**	**Range**	**Calculation**
$CQ_{i,p,fprod,prod}$	Cost of treatment product *prod* or of family of product *fprod*[1] for practice *p* on block *i*	UM/ha	Block	$[0 \; ; +\infty[$	$Q_{i,p,fprod,prod} \times CuProd_{fprod,prod} \times NbTRT_{i,p,fprod,prod}$
$IFT_{i,p,fprod,prod}$	TFI corresponding to the spreading of treatment product *prod* belonging to the family *fprod* for practice *p* on block *i*	-	Block	$[0 \; ; +\infty[$	$NbTRT_{i,p,fprod,prod} \times \%IFT_{i,p,fprod,prod} \div 100$
$IFT_{i,p,fprod}$	TFI corresponding to the spreading of the family of treatment product *fprod* for practice *p* on block *i*	-	Block	$[0 \; ; +\infty[$	When products are informed: $$\sum_{prod} IFT_{i,p,fprod,prod}$$ When only the product famiies are informed[1]: $NbTRT_{i,p,fprod,""} \times D_{i,p,fprod,""} \times InIFT_{i,p,fprod,""}$

[1] When the products are not mentioned and calculations are only made on the families of product, the *prod* index is equal to "".

A.7. Results variables

	A.7.1. Economic results				
Variable	**Definition**	**Unit**	**Object**	**Range**	**Calculation**
CA_i	Gross product/ha for block i	UM/ha	Block	$[0 ; +\infty[$	$\sum_j PV_{i,j} \times \%PV_{i,j} \times Rdt_i \div 100$
CA	Gross product/ha for the modelled part of the farm	UM/ha	Farm	$[0 ; +\infty[$	$\sum_i (CA_i * S_i) \div \sum_i S_i$
$Ccond_i$	Management cost /ha for block i	UM/ha	Block	$[0 ; +\infty[$	$TotChV_i + Cprot_i + CMo_i$
ChF	Fixed costs/ha on the modelled part of the farm	UM/ha	Farm	$[0 ; +\infty[$	$\sum_{chf} CChF_{chf} \times \%CHF_{chf} \div 100$
CMo_i	Labour cost/ha for block i	UM/ha	Block	$[0 ; +\infty[$	$\sum_{mo} (CuMO_{mo} \times \sum_p \sum_m DT_{i,p,mo,e,m})$
$Cprod_i$	Cost of treatment products/ha for block i	UM/ha	Block	$[0 ; +\infty[$	$\sum_p \sum_{fprod} \sum_{prod} CQ_{i,p,fprod,prod}$
MB_i	Gross margin/ha for block i	UM/ha	Block	$[0 ; +\infty[$	$CA_i - CCond_i$
MB_{cult}	Average gross margin/ha for crop $cult$	UM/ha	Farm	$[0 ; +\infty[$	$\sum_{cult} (MB_i \times S_i) \div \sum_{cult} S_i$
MB_{var}	Average gross margin/ha for cultivar var	UM/ha	Farm	$[0 ; +\infty[$	$\sum_{var} (MB_i \times S_i) \div \sum_{var} S_i$
MB	Gross margin/ha on the modelled part of the farm	UM/ha	Farm	$[0 ; +\infty[$	$MBTot \div \sum_i S_i$
$MBTot$	Total gross margin on the modelled part of the farm	UM	Farm	$[0 ; +\infty[$	$\sum_i (MB_i \times S_i)$
MN	Net margin/ha on the modelled part of the farm	UM/ha	Farm	$[0 ; +\infty[$	$MB - ChF$
$MNTot$	Total net margin on the modelled part of the farm	UM	Farm	$[0 ; +\infty[$	$MN \times \sum_i S_i$
$TotChV_i$	Total variable costs/ha for block i	UM/ha	Block	$[0 ; +\infty[$	$\sum_p \sum_{chv} CChV_{i,p,chv}$

	A.7.2. Output variables for 'Costs per operation'				
Variable	**Definition**	**Unit**	**Object**	**Range**	**Calculation**
$CT_{i,p}$	Cost/ha for practice p on block i	UM/ha	Practice + Block	$[0 ; +\infty[$	$(\sum_m \sum_{mo} DT_{i,p,mo,e,m} \times CuMO_{mo}) + \sum_{prod} CQ_{i,p,fprod,prod} + \sum_{chv} CCHV_{i,p,chv}$
CT_p	Cost/ha for practice p	UM/ha	Practice + Block	$[0 ; +\infty[$	$\sum_i (CT_{i,p} \times S_i) \div \sum_i S_i$

<table>
<tr><td colspan="6" align="center">A.7.3. Output variables for 'TFI results'</td></tr>
<tr><th>Variable</th><th>Definition</th><th>Unit</th><th>Object</th><th>Range</th><th>Calculation</th></tr>
<tr><td>$IFT_{i,fprod}$</td><td>TFI corresponding to the spreading of the family of product fprod on block i</td><td>-</td><td>Block</td><td>[0 ; +∞[</td><td>$\sum\limits_{p} IFT_{i,p,fprod}$</td></tr>
<tr><td>IFT_i</td><td>Total TFI total of block i</td><td>-</td><td>Block</td><td>[0 ; +∞[</td><td>$\sum\limits_{i} IFT_{i,p,fprod,prod}$</td></tr>
<tr><td>IFT/UP_i</td><td>TFI per weight unit of block i</td><td>-</td><td>Block</td><td>[0 ; +∞[</td><td>$IFT_i \div (Rdt_i \times S_i)$</td></tr>
<tr><td>IFTmoy</td><td>Average TFI for the scenario weighted by the area of each block</td><td>-</td><td>Farm</td><td>[0 ; +∞[</td><td>$\sum\limits_{i}(IFT_i \times S_i) \div \sum\limits_{i} S_i$</td></tr>
</table>

<table>
<tr><td colspan="6" align="center">A.7.4. Labour balance results</td></tr>
<tr><th>Variable</th><th>Definition</th><th>Unit</th><th>Object</th><th>Range</th><th>Calculation</th></tr>
<tr><td>BILMO</td><td>Annual labour balance</td><td>UT</td><td>Farm</td><td>[0 ; +∞[</td><td>$Operm - DT$</td></tr>
<tr><td>$BILMO_m$</td><td>Labour balance for month m</td><td>UT</td><td>Farm</td><td>[0 ; +∞[</td><td>$Operm_m - DT_m$</td></tr>
<tr><td>$BILMO_{m,e}$</td><td>Labour balance of permanent staff e for month m on the modelled part of the farm</td><td>UT</td><td>Farm</td><td>[0 ; +∞[</td><td>$DispMO_{m,mo,e} - DTMOD_{m,e}$</td></tr>
<tr><td>$BILMO_{m,mo}$</td><td>Labour balance of labour category mo for month m on the modelled part of the farm</td><td>UT</td><td>Farm (modelled part)</td><td>[0 ; +∞[</td><td>$Operm_{m,mo} - DTMOD_{m,mo}$</td></tr>
<tr><td>DT_m</td><td>Total demand of labour for month m on the whole farm</td><td>UT</td><td>Farm</td><td>[0 ; +∞[</td><td>$DTMOD_m + \sum\limits_{act} DAct_{m,act}$</td></tr>
<tr><td>DT</td><td>Total demand of labour on the whole farm</td><td>UT</td><td>Farm</td><td>[0 ; +∞[</td><td>$\sum\limits_{m} DT_m$</td></tr>
<tr><td>$DTMOD_{m,e}$</td><td>Total demand of labour for permanent staff e for month m on the modelled part of the farm [1]</td><td>UT</td><td>Farm (modelled part)</td><td>[0 ; +∞[</td><td>$\sum\limits_{i}(\sum\limits_{p} DT_{i,p,mo,e,m} \times S_i)$</td></tr>
<tr><td>$DTMOD_{m,mo}$</td><td>Total demand of labour for labour category mo for month m on the modelled part of the farm [1]</td><td>UT</td><td>Farm (modelled part)</td><td>[0 ; +∞[</td><td>$\sum\limits_{i}(\sum\limits_{p} DT_{i,p,mo,e,m} \times S_i)$</td></tr>
<tr><td>$DTMOD_m$</td><td>Total demand of labour for month m on the modelled part of the farm</td><td>UT</td><td>Farm (modelled part)</td><td>[0 ; +∞[</td><td>$\sum\limits_{mo} DTMOD_{m,mo}$</td></tr>
<tr><td>$Operm_{m,mo}$</td><td>Labour supply of labour category mo for month m</td><td>UT</td><td>Farm</td><td>[0 ; +∞[</td><td>$\sum\limits_{e} DispMO_{m,mo,e}$</td></tr>
<tr><td>$Operm_m$</td><td>Total labour supply of permanent staff for month m</td><td>UT</td><td>Farm</td><td>[0 ; +∞[</td><td>$\sum\limits_{mo} Operm_{m,mo}$</td></tr>
<tr><td>Operm</td><td>Total labour supply of permanent staff</td><td>UT</td><td>Farm</td><td>[0 ; +∞[</td><td>$\sum\limits_{m} Operm_m$</td></tr>
</table>

[1] The two equations are identical and are based on the same $DT_{i,p,mo,e,m}$. But in one case sums are made by individual permanent staff, in the other by category of labour mo.