



EU Project REDNEX

COWNEX

USER GUIDE

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CowNex User Guide



The CowNex simulator is used to calculate protein synthesis and nitrogen excretion in dairy cattle herd, including heifers, depending on herd management.

It performs these calculations throughout the year and measures the impact of management changes, particularly nutrition, on the efficiency of nitrogen use by the herd and the release of fecal or urine nitrogen.

The amount of nitrogen to manage as manure is considered separately from the quantities directly returned to pasture.

Brief description of CowNex model

The input-output of CowNex and the main basis of the model are summarized in Figure 1. Most of the equations used in this tool have been produced by previous developments and have been published earlier. The originality of CowNex lies in the structure of different models at the herd level with a user-friendly interface and simplified inputs.

CowNex simulates the dairy herd as a set of animal classes through which the animals are passing along the year. Each of these classes covers 3 months of time, both during the rearing phase of heifers or during the lactation of dairy cows. Primiparous are differentiated from multiparous cows' classes. Lactation period is divided into 3 classes: beginning (0-3 month), mid (4-6) and end of lactation (7 and more), the latest class being a bit longer (≈ 4 months). Lactation is followed by a class for dry cows. This representation is derived from a model of a dairy herd demographics (GEDEMO), which generates the matrix of herd structure according to farming practices (breeding periods, age at first calving, culling) (Coquil et al., 2005). The user selects a type of matrix adapted to the herd management he wants to simulate and specifies the date of beginning of the calving period and the average number of cows. This simplified definition allows a rapid definition of the herd.

CowNex calculates the consumption, production and excretion of each class of animals according to their diet, previously defined by the user for several feeding groups (calves, heifers, cows) along the

year. Consumption and production are calculated on the basis of Graze'In model, developed within the European project Grazemore (Delagarde et al., 2011; Faverdin et al., 2011). The feeding system and the feed tables used for calculations are those of INRA 2007 (Agabriel et al., 2007). In the case of grazing management strategy, an average daily grass offer is used to calculate feed intake. It then allocates the different forms of excretion (feces and urine) between grazing and effluent storage, according to the time spent grazing each day, deduced from the provided diet plan. The amounts of nitrogen excreted are calculated before any volatilization loss, because the model is limited to herd sensu stricto. However, the results of the CowNex simulations can be used easily to calculate further emissions during storage and spreading, according to other characteristics of the farming system. Urinary nitrogen being considered equivalent to total ammonia nitrogen (TAN) in manure management, it also gives the opportunity to use more accurate models for calculating emissions. After the simulation of one year, the software summarizes the total amount of intake and excretion of the herd, both for the average individual animal of each feeding group and for the whole herd. This report focuses on the dry matter and nitrogen intake (Produced on farm & imported), the excreted nitrogen (urine & feces x pasture & storage). Indicators of efficiency and self-sufficiency are provided for each group and for the whole herd.

In IT terms, CowNex is structured on the basis of the generic whole farm model MELODIE (Chardon et al., 2012), rewritten using the VLE platform RECORD (Bergez et al., 2012), from which it takes the objects of the dairy herd. Two programs have been created for CowNex, one dedicated to the user interface and the other to make the connection between the input data and the MELODIE model. The formalism of VLE enables a simplified reuse of this part of the model for the Web application.

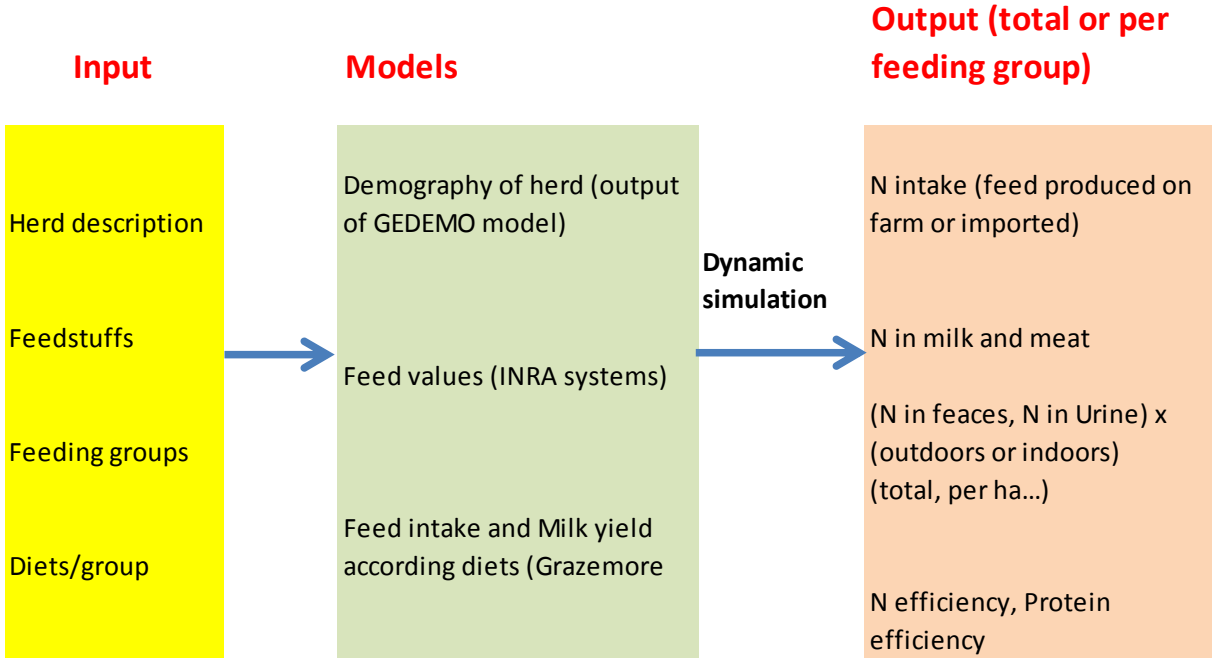


Figure 1: Simplified representation of the CowNex tool.

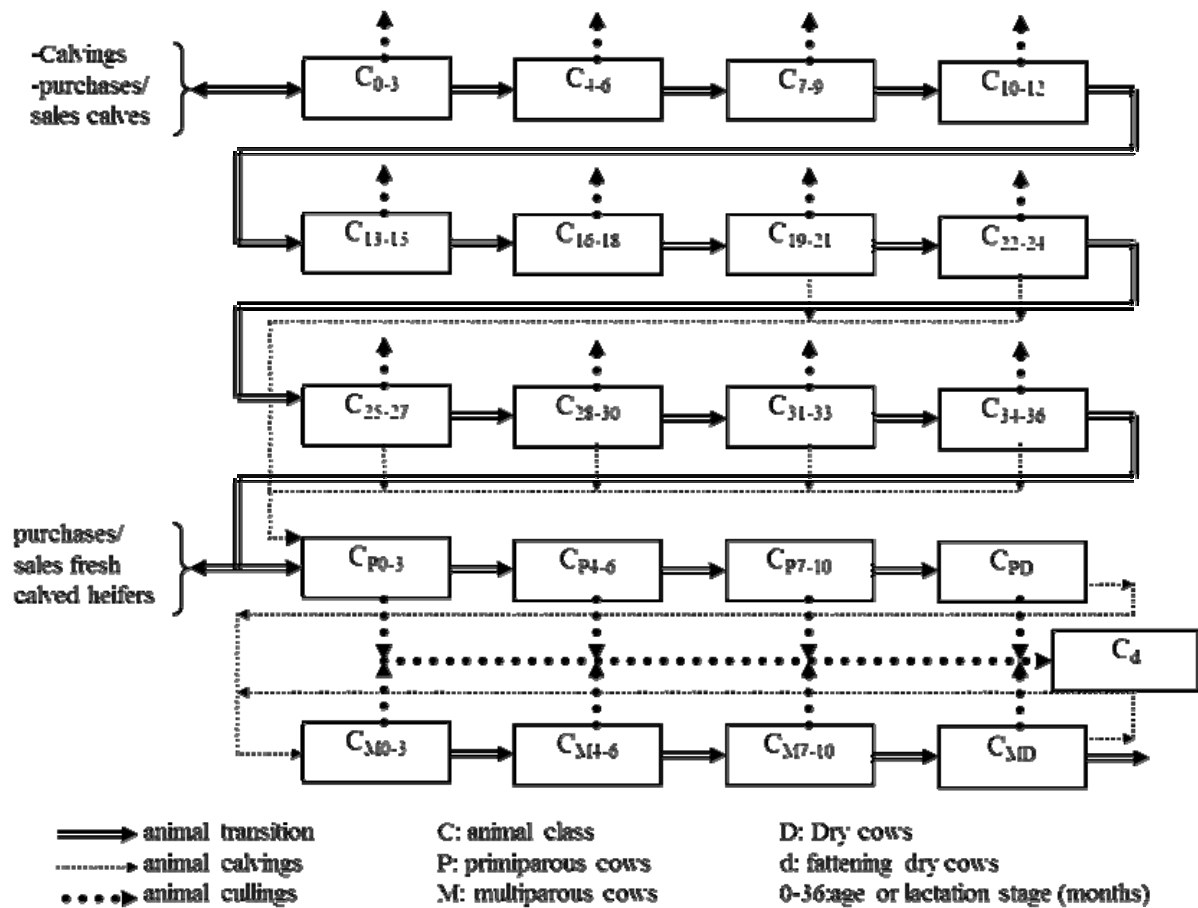


Figure 2: Schematic representation of the demography structure (animal classes) of a dairy herd used in CowNex.



Release 1.0

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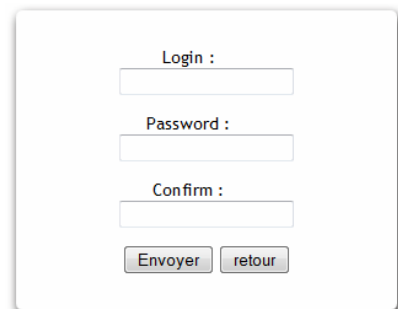


Access to CowNex

The CowNex software can be accessed without restriction via an Internet network with a multilingual Web interface (French, English) at the address: <http://www.cownex-record.inra.fr/>. The web site is configured to work with navigators like Firefox or Chrome, but for technical reasons it is not accessible with Internet Explorer.

To use this application, you must open an account. For this:

- Click on "Subscription" on the top right of the screen
- Enter a username in the box "login"
- Enter a password and confirm it in the following two boxes.



The image shows a login form with three text input fields. The first field is labeled 'Login :', the second 'Password :', and the third 'Confirm :'. Below the fields are two buttons: 'Envoyer' and 'retour'.

This registration allows, when a new connection occurs, to find back the software with previously filled items. However, only the status of the last simulation is saved (herd characteristics, food selection, feeding groups, feeding plan). This facility allows quitting the application without losing the information describing a herd and enables to quickly test a new feeding plan for example. **However, it is not possible to save several scenarios for the same user.**

Warning! As the application does not require an e-mail address, it cannot return a forgotten password to the user. In this case, the user must create a new account, possibly with a new username. Unused accounts are automatically canceled after a defined period to reduce storage of information. It is also possible that the entire database of CowNex users is reset for the needs of maintenance of the application. If a user cannot reopen his previous account, he has to recreate himself a new one directly.

Once registration is completed, the user enters his or her login (login) and password (password), selects the language (French or English) he wants to use for this application and then click the "send" button. It can then access the CowNex software to perform its simulations. From the first identification, the simulator provides the data of a simple case study, which can be used by the user to directly start some calculations and which can then be customized as he wants.

Description of the user interface

The user interface CowNex account consists of a series of tabs:

The first two tabs are information tabs about the tool.

The tabs "Herd", "Feed", "Feeding Groups" and "Diet plan" are input data to describe the simulated system.

The last tab "Simulation" is available as soon as all data has been entered.

The « First Step » tab

The CowNex interface presents a series of tabs that must be filled in sequentially before running a simulation.

To run a simulation, you have to:

- Describe the main characteristics of the herd : Herd
- Select the feedstuffs used to feed the herd during the year : Feed tab
- Define the main groups of cattle gathering several classes of animal fed with the same diet during the year : Feeding Groups tab
- Indicate for each feeding group the different diets offered during the year : Diet Plan tab
- You have to give a title to the scenario and run the simulation to get results : Simulation tab

By default, a very simple scenario is proposed at the first use. Then you will define each simulation starting from the last simulation performed.



Caution: You can always restart from the initial scenario by clicking the Reset button, but your last scenario will be lost.

The "Herd" tab

The description of the herd requires some general characteristics of the herd.

The number of parameters required to describe the herd management has been minimized to simplify the simulations (Figure 1). The parameter on the grouping of calving ("herd structure") proposes to choose a demographic structure of the herd corresponding either to grouped calving (all calvings over 3-4 months each year) or to spread calving (calving all along the year). When the option "grouped calving" is used, the parameter "Month of the first calving" is required to indicate the month of the first calving. This parameter will have no effect when the option "spread calving" is used. The parameter "Number of cows" is used to size the herd, indicating the average number of dairy cows during the year.

Only few parameters are required to describe the characteristics of the cows. The potential milk production corresponds to the average potential for milk yield expected for multiparous cows during a standard 305-day lactation, possibly adjusted to environmental factors. This parameter is indicative of the average potential of the cows and the simulated production can be either lower or higher than the actual production, according to the herd feeding conditions. The adult body weight is an average indication of the animal size. It is mainly based on the genetic type and age at first calving. Finally, the

protein content is the average potential protein content of lactating cows fed with an ideal diet (balance of amino acids in particular). With many diets unbalanced for amino acids or proteins, the simulated protein content can be lower than indicated in the characteristics of the herd. The true protein content of milk is not the crude protein content, which is still commonly used in some countries. It can be approximated by the CP content (g/kg) minus 1.6.

Home
First Step
Herd
Feed
Feeding Groups
Diet Plan
Simulation

Simulation Start Date : 01 September

Herd Management

Herd Structure ? :

First calving month ? :

Cow number ? :

Herd Characteristics

Milk potential ? : kg

Mature Live Weight : kg

True Protein Content ? : g/kg

Farm AUA ? : ha

Figure 1: Example of a dairy herd of 100 high producing Holstein cows (9500 kg milk, 650 kg live weight) with grouped calving starting from the month of August, at two years old for heifers. All heifers are reared. The total area of the farm is 141 ha.

If the input fields on this tab are not compliant to the limits indicated in the table 1, the user cannot switch to the next tab.

Table 1: Limits of the values registered in the “Herd” tab.

	min	max	Type
<i>Number of cows</i>	10	5000	Integer
<i>Potential milk yield (kg/year/cow)</i>	3000	14000	Integer
<i>Mature Live Weight (kg)</i>	300	800	Integer
<i>Protein content (g/kg milk)</i>	20	40	Real

The “Feed” tab

The CowNex tool has made the choice to simplify as much as possible the inputs of the simulation, which should facilitate the use of the tool, but may introduce some constraints important to know. The choice was made to avoid the use of the analytical composition of each feed required to calculate the nutritional feed values. This information is often not available to users and the comprehensive inputs could discourage the users. The option of a choice from a comprehensive list was preferred. In return, it is not possible to use a feed with specific characteristics other than those in the database of CowNex. However, more than a thousand roughages are available, often with various stages of maturity which make possible to find one of them close to the characteristics of the desired feed. Also, most of the raw feedstuffs used as concentrate or in commercial compounds are available in the database. This database has been enhanced with some common generic commercial feeds that have been placed in a specific list of feeds concentrated formulas. The same is true for some feeds rich in amino acids.

The "Food" tab consists of two distinct parts to describe the food: the upper part concerns the conserved feedstuffs or those distributed at trough, the lower part concerns the grasslands characteristics in grazing conditions and provides a feed value evolving along the year (Figure 2).

Choice of feeds offered indoor

The screenshot displays the 'Feed' tab interface of the CowNex tool. At the top, there are navigation tabs: Home, First Step, Herd, Feed (selected), Feeding Groups, Diet Plan, and Simulation. The main content area is titled 'List of feedstuffs' and contains a search tool and a list of feedstuffs.

Search tool to find feedstuffs in the CowNex database

Food Type: Forages
Conservation Mode: Silages
Type / Species: Grasses
Species / Place: Perennial ryegrass
Year: Choose
Conservation Charac: [Dropdown]

Search [Button] [>>] [<<]

Feedstuff	DM	UFL	PDIN	PDIE	OMD	CP	ME	LysDi	MetDi
Grasses Perennial ryegrass Early flower. 1st gr. without ears or buds 10% ear emerg. -1 we.	18.1	1.01	89	64	79.0	151	2824	7.39	2.00
Grasses Perennial ryegrass Early flower. 1st gr. with ears or buds 10% ear emergence	18.6	0.97	83	62	77.0	141	2757	7.39	2.00
Grasses Perennial ryegrass Early flower. 1st gr. with ears or buds 50% ear emergence	18.7	0.92	72	59	74.0	123	2624	7.41	2.01
Grasses Perennial ryegrass Early flower. 1st gr. with ears or buds end of heading	19.1	0.85	65	54	70.0	112	2444	7.41	2.01
Grasses Perennial ryegrass Early flower. 1st gr. with ears or buds early flowering	20.3	0.78	65	52	67.0	111	2307	7.38	2.00
Grasses Perennial ryegrass Late flower 1st gr. without ears or buds 10% ear emerg. -1 we.	19.3	0.91	71	58	75.0	122	2599	7.40	2.01

User's list

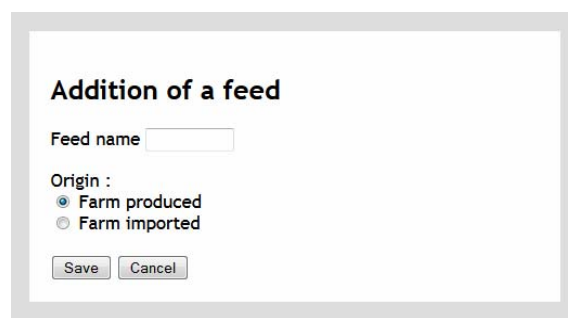
List of feedstuffs

- FreshGrass (In)
- MilkP-LaitP (Out)
- MaizeS-EMais (In)
- Straw-Paille (In)
- Barley-Orge (In)
- Soyabean M (Out)

Figure 2: example of feed choice. The screen displays all types of forages corresponding to the criteria “forages”, “silages”, “grasses”, “Perennial ryegrass” and the user selects the specific silage “Early flower. First growth with ears or buds, 50% ear emergence” with feed values as close as possible to the expectations of the user.

Add a feestuff to the user's list

The list of available feed is very long, a simplified method of search is proposed. The procedure offers to select the feeds with a set of indicators proposed in the INRA software since the version 2 (INRA, 1995). The information of the first three indicators is necessary to start the search function in the database (Figure 2). More than three criteria can be used if the resulting list is too long or if these criteria are known precisely. After selecting the first three criteria (at least), click the **Search** button to display a list of feeds that meet these criteria in a table of search results summarizing the main characteristics of feed. To place a feed in the feed list of the user for the case study, then just select one of them in the search list of feedstuffs. The selected feed appears highlighted in yellow. The user must then click the button with the arrows **>>** to transfer the selected feed in the user's database. A window opens (Figure 3) to provide a short name for the feed in the list and to specify if the feed is produced on farm or purchased (imported to the farm). This information will be used at the end of the simulation to calculate an indicator of protein self-sufficiency of the herd, but is not used for economic aspects. It is possible to select more feeds than necessary for one particular case to expand the list for all simulations.



The image shows a dialog box titled "Addition of a feed". It has a white background and a grey border. At the top, the title "Addition of a feed" is centered. Below the title, there is a text input field labeled "Feed name". Underneath that, the text "Origin :" is followed by two radio buttons: "Farm produced" (which is selected) and "Farm imported". At the bottom of the dialog, there are two buttons: "Save" and "Cancel".

Figure 3: Window to add a new feed in the user's list to give it a short name in the list and to specify if the feed is produced on the farm or purchased (imported).

Consult a feed of the user base values

When the user clicks on a feed in the list of selected feedstuffs, he finds the full description of it in the left panel (bottom left for GrazedGrass and top left for other feedstuffs).

Delete a feed from the user database

It is possible to remove feeds from the user's list. To do this, the user has to select the feed in this list and to click the **<<** button. The feed "GrazedGrass" is the only one that cannot be destroyed. Note that green grass is also available in the feed database of CowNex for cases where it is distributed indoor. In these cases, the user has to insert this type of feed into the user's feed list. When grass is grazed, the "GrazedGrass" feed will be used. The values of this grass will be calculated based on the criteria provided in the description of grazed grass for each month of the year, and are not chosen in the feed table.

Description of grazed grass.

CowNex is designed to describe the characteristics of an average type of pasture for a given herd. Two types of grassland are considered: Pure monospecific grassland and multispecies permanent grassland. For each type, a typical composition of grass with crude protein (CP) and ADF (Acid Detergent Fiber) is proposed corresponding to good grassland in maritime regions (western France). This simplified composition is sufficient to calculate the feed values of the grass grazed during the year (Figure 4). It can be adjusted to the specific conditions of each operation by entering appropriate CP and NDF values for the different months of the year. These values will be used depending on the feeding plan designed thereafter. The winter values are barely used in the diet calculations. Just leave the default values for these periods, if no other information is available. If you do not want to keep changes made and if you want to return to the default values of the software, just click on the button Reset Grass

Grass type

Pure grassland ?

	J	F	M	A	M	J	J	A	S	O	N	D
CP	200	200	210	210	185	170	160	170	190	200	200	200
ADF	225	225	230	235	270	275	280	280	260	245	225	225

Reset Grass ?

Figure 4: table with the characteristics of the GrazedGrass feed during the year. This table is used to calculate the feed values of grazed grass depending on the type of grassland.

The « Feeding groups » tab

Although the software takes into account 3-month classes to characterize the structure of the herd and to calculate their consumption, it is not necessary to describe the feeding management for each of these classes. It is possible to form feeding groups with several classes receiving the same diet. By default, the software proposes to establish three feeding groups (it is the minimum); One for calves 0-3 months, the other for breeding heifers, the third for dairy cows. It is not possible to combine two of these groups into one.

Creation of new supply batches

It is possible to create more than the three groups present in the example of CowNex at the first use. For example it is possible to make a group for heifers less than one year, another for heifers over one year, if their diets differ. Similarly, it is possible to make different groups for cows in early, mid and late lactation, if they are fed with different complete mixed diets for example.

To create a new feeding group, click on the + following the heading "**List of feeding groups**", then go to the "**Name**" box to enter the name of the new group (Figure 5 and 6). By default, the "**Classes**" list is empty because all classes of animals are used in the three groups of the example. It is first necessary to transfer classes from existing feeding groups to the "**Classes**" list using the << button,

then choose the group to fill in the "List of items" by clicking above and transfer the appropriate classes from the "Classes" list to the new list using the **>>** button. To fill a group with different classes, classes must share the same color (you cannot pool calves and heifers or heifers and cows, for example).

Removing a feeding group

To destroy a lot of animals, simply select the batch and click the red cross **X** and it disappears (Figure 6). The classes of this group are automatically moved in the "Classes" list. All classes must be placed in a feeding group. Otherwise, the access to the next tab is blocked.

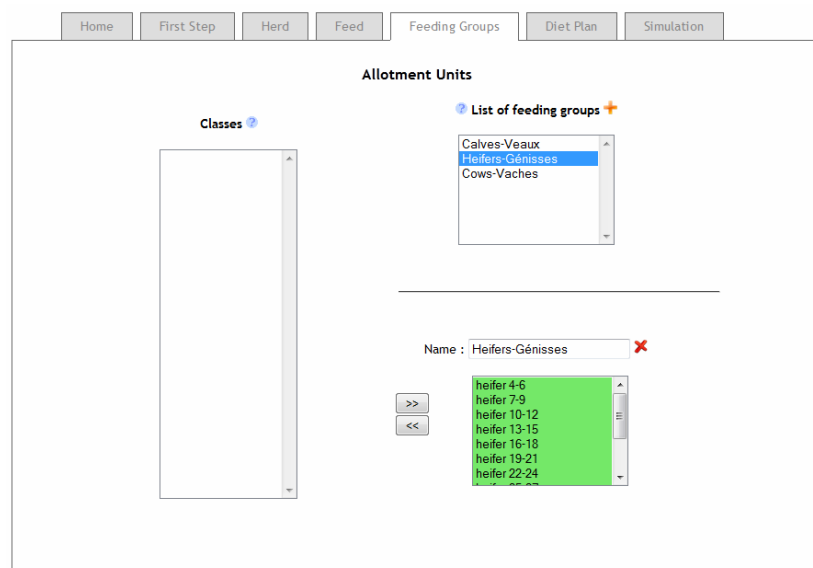


Figure 5: Constitution of feeding groups within the dairy herd. The heifers feeding group is displayed with all the heifers classes included in this group.

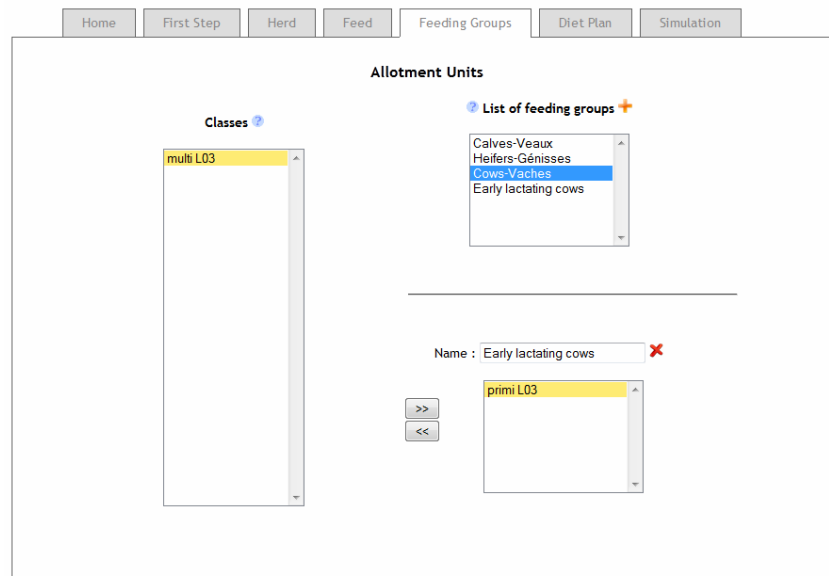


Figure 6: Creation of a new feeding group within the dairy herd. A group “Cows in early lactation” is being established and will gather both primiparous and multiparous cows during the first 3 months of lactation.

The « Diet Plan » Tab

This section is used to describe in details the various feeding plans within the herd. It is the most important tab for further calculations and must be completed with care avoiding simulation of feeding systems which do not correspond to the situation described. Of course, it is assumed that the amount of feeds required for the proposed rations are available and the production of grass will be sufficient to satisfy normal grazing conditions.

To each previously set feeding group corresponds a tab with its feeding plan.. The feeding schedule is therefore presented as a series of diets with a starting and ending date and a detailed composition of each diet. At the bottom of each table, a "Total" line enables to check if the sum of columns yields 100, and the last line specifies the time spent outdoors (line "**time outdoors (h)**" in hours per day). Each feeding plan must start at the beginning of the simulation (on September 1st) and end on August 31. The first line is always dedicated to grazing ("GrazedGrass" food). It is possible to create a new ration by clicking , or to delete the one you do not want by clicking . Every creation or deletion of a diet requires an update of the starting and ending dates.

Caution: it should be noticed that the date format, regardless of the language use in CowNex is the following: MM / DD / YYYY. Some errors can result from inattention on dates, especially in years.

Calves

The class of calves only concerns the first three months of life. It is therefore simply designed to inform on the average daily quantities consumed during the first 3 months of life. Therefore these quantities have to be given in kg dry matter (DM) in the left column of the diet (Figure 7). In general, this diet is often the same all over the year, except if the type forage introduced in early life changes during the year or if the calf is fed by its mother at grazing. Then there may be a period outdoors and it is necessary to indicate the time spent out by the calf in "**Time outdoors (h).**"

Home First Step Herd Feed Feeding Groups Diet Plan Simulation

Calves-Veaux Heifers-Génisses Cows-Vaches

Calves-Veaux

Diet 1 (365 Days)
 Begin : 9/1/2012
 End : 8/31/2013 +
 (mm/jj/aaa)

	DM (kg/day)	%
FreshGrass		
MilkP-LaitP	0.60	
MaizeS-EMais	0.30	
Straw-Paille		
Barley-Orge	0.60	
Soyabean M		
Total	1.5	
Time outdoors (h)		0

Copy this plan to

Figure 7: Example of a feeding plan for calves. One diet is offered throughout the year corresponding to the average daily amounts of feeds during the first three months of the calf's life, 0.6 kg DM of milk, 0.30 kg DM of corn silage and 0.60 kg DM barley.

Heifers

In contrast to the feeding of calves, the ration of heifers can only be described as a complete ration in % DM of each ingredient in the right column of each diet. If there is only one, as in the case of grazed grass, just indicate 100% in the right column of the ration (Figure 8). This choice is motivated to avoid the user to inform too much feeding groups and to avoid inconsistencies. Indeed, feed intake varies greatly between heifers' classes and if the feeding plan is applied uniformly to the 13 classes of heifers with some fixed quantities, inconsistencies are likely to occur in some classes.

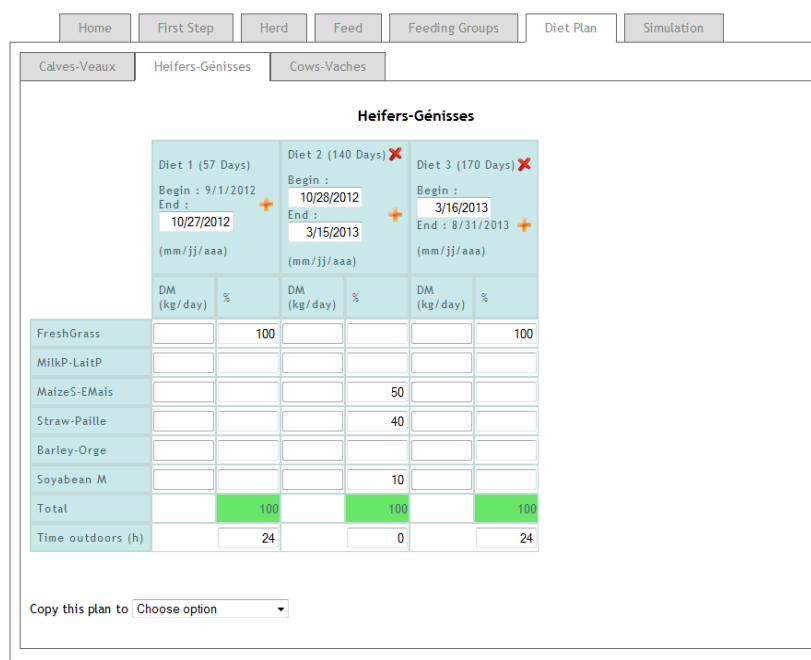


Figure 8: Example of a very simple screen of annual feeding plan for heifers. The first diet is offered from September 1st to October 27th, and during this period the heifers are only grazing before they receive a ration composed with 50% corn silage, 40% straw and 10% soybean meal in barn until spring. From March 31th to August 31th, heifers are grazing again, being outside 24h/day.

Cows

For dairy cows, it is possible to use the two columns to describe a diet, the left column with feeds distributed in fixed amounts and the right one with ad libitum alone or mixed feeds. To describe a total mixed diet, only fill the right column (Figure 9). It is also possible to describe situations with a single forage fed *ad libitum* with 100% in the right column, with the possibility to add some feeds distributed in fixed amounts (forage or concentrate) in the left column. For semi-complete rations (TMR and some complementary feeds distributed in fixed quantities), the user indicates the proportions of the mixed ration ingredients in the right column and supplementary feeds distributed in fixed amounts in the left column (kg DM/day).

Home First Step Herd Feed Feeding Groups Diet Plan Simulation

Calves-Veaux Heifers-Génisses Cows-Vaches

Cows-Vaches

	Diet 1 (208 Days)		Diet 2 (34 Days) ✘		Diet 3 (124 Days) ✘	
	Begin : 9/1/2012	End : 3/27/2013	Begin : 3/28/2013	End : 4/30/2013	Begin : 5/1/2013	End : 8/31/2013
	(mm/jj/aaa)		(mm/jj/aaa)		(mm/jj/aaa)	
	DM (kg/day)	%	DM (kg/day)	%	DM (kg/day)	%
FreshGrass				100		100
MilkP-LaitP						
MaizeS-EMais		70	7			
Straw-Paille						
Barley-Orge		15	2			
Soyabean M		15	1			
Total	0	100	10	100	0	100
Time outdoors (h)		0		8		20

Figure 9: Example of a very simple annual feeding plan for cows. The first ration is distributed from September 1st to March 27th, the cows are all the time in barn. They receive a winter complete mixed diet composed of 70% corn silage, 15% soybean meal and 15% barley. From March 31th to April 30th, they receive a ration of transition diet, with grazing during the day (8 h/day) and an additional 7 kg DM of maize silage, 1 kg DM of soybean meal and 2 kg DM of barley indoor. From May to August, the cows are grazing all day long with 2 kg DM of barley at milking parlor and the time spent outdoors is 20h / d (due to the milking two times a day).

NOTES:

- It is easily possible to copy the diet calendar from one feeding group to another. To do this, after filling up the feeding plan of the first group, simply use the "**Copy this plan to**" option at the bottom of the screen to transfer this information to another group. Then, the user can adjust the feeding plan to the specificity of this second group. It is many useful with different groups of cows with the same forage diet during the year, but different concentrates supplementation.
- While a diet composition of cows or heifers does not fit a total of 100%, the access to the "Simulation" tab is not allowed.

The « Simulation » tab

When all data is entered, it is possible to access the simulation tab and to run the simulation by clicking the Run simulation button. The computation time is usually about 5 seconds, during this period the model simulates production, intake and excretion, for each class of animals and each day of the year, according to their feeding plan.

NOTE: At this step, the data entered into the system by the user interface are stored in the user account on the server of the web application.

The results are then displayed in three sub-tabs: a tab with the results of nitrogen inputs, a tab with the results of the nitrogen output and a third tab to recover results in a delimited text file type .csv to view and reuse the results as a spreadsheet.

The "N Inputs" sub-tab

The screen reports nitrogen inputs accumulated for the year for each feeding group (per animal.year and total) and for the whole herd, both in kg of dry matter (white line) and kg of nitrogen (blue line; Figure 10).

The first table shows the amounts of ingested DM and N of each feed and total diet. A final column also indicates the content of crude protein (CP) of average annual diet. It is important to notice here that if there are 50 calves born during the year, the size of the 0-3 months calves class will be on average 12.5 animal.year.

The second table summarizes the total DM and N intake per feeding group and for the whole herd, but splitting these amount with the part produced on farm and the part imported. These data are used to calculate % self-sufficiency of herd feeding both in terms of DM and N (proteins).

The screenshot shows a software interface with a navigation bar at the top containing tabs: Home, First Step, Herd, Feed, Feeding Groups, Diet Plan, and Simulation. The 'Feeding Groups' tab is active, and within it, the 'N Inputs' sub-tab is selected. The main content area displays two tables.

N Inputs : Annual Diet

Feeding Groups (size)	KG	FreshGrass	MilkP-LaitP	MaizeS-EMais	Straw-Paille	Barley-Orge	Soyabean M	Total Diet	CP
Cows-Vaches (100.0) per animal	DM	2163.3	0.0	3818.3	0.0	835.2	801.2	7618.0	
	N	61.6	0.0	42.2	0.0	15.5	66.1	185.0	152.0
Heifers-Génisses (83.6) per animal	DM	1804.3	0.0	387.8	310.2	0.0	77.6	2580.0	
	N	53.2	0.0	4.3	1.7	0.0	6.4	66.0	159.0
Calves-Veaux (12.5) per animal	DM	0.0	219.0	109.5	0.0	219.0	0.0	548.0	
	N	0.0	8.5	1.2	0.0	4.1	0.0	14.0	157.0
Herd (196) Total	DM	367127	2743	415605	25926	86261	86603	10745	
	N	10615	107	4588	145	1601	7150	265	154

Feeding Groups (size)	KG	Intake	Produced	Imported	% Self sufficiency
Cows-Vaches (100.0) Total	DM	761792.2	681670.2	80122.0	89.5
	N	18545.1	11930.3	6614.9	64.3
Heifers-Génisses (83.6) Total	DM	215614.3	209132.9	6481.4	97.0
	N	5487.9	4952.8	535.1	90.2
Calves-Veaux (12.5) Total	DM	6858.4	4115.0	2743.3	60.0
	N	172.7	66.1	106.7	38.2
Herd (196) Total	DM	984265	894918	89347	91
	N	24206	16949	7257	70

Figure 10: Example of screen output results on the annual diet (dry matter and nitrogen)

The "N outputs" sub-tab

The second screen shows the results of different nitrogen outputs of the dairy herd (Figure 11).

The first table of this screen shows, for each feeding group (per animal.year and total) and for the whole herd, the partition of nitrogen intake between the different outputs: milk, meat, faeces and urine. The entire meat of the calf is assigned to him at birth but could be reallocated to its mother

depending on the situation. This choice is arbitrary, but can be easily reallocated. The last line shows the total for the whole herd, an additional line giving an indication of these N outputs per ha.

The second table shows the cumulative excretion of faeces, urine and total for each feeding group (per animal.year) and for the whole herd, again with an additional line indicating these N outputs per ha. This table displays the nitrogen from urine to have an order of magnitude of the variable total ammonia nitrogen excreted (TAN English) often used to calculate gaseous emissions. The amounts excreted in buildings (controllable) and in grazing situations (uncontrollable) are accumulated separately also to perform calculations on emissions and manure management.

A final table displays the details of the production of milk and milk nitrogen.

Annual N Partition (Kg)

Feeding Groups (size)	Milk	Meat	Faeces	Urine	Total Diet	N Efficiency %
Cows-Vaches (100.0) per animal	50.2	0.0	68.7	64.7	185.5	27.1
Heifers-Génisses (83.6) per animal	0.0	6.5	18.9	40.6	65.7	9.9
Calves-Veaux (12.5) per animal	0.0	6.4	3.9	2.9	13.8	46.3
Herd (196) Total	5025	622	8505	9900	24052	23.5
Total/ha	35.6	4.4	60.3	70.2		

Annual N Excretion (Kg)

Feeding Groups (size)	Total	Controllable			UnControllable			% Controllable
		Faeces	Urine	Total	Faeces	Urine	Total	
Cows-Vaches (100.0) Total	13343.7	5280.9	4270.5	9551.4	1594.0	2198.3	3792.3	71.6
Heifers-Génisses (83.6) Total	4976.9	434.9	428.8	863.7	1147.1	2966.1	4113.2	17.4
Calves-Veaux (12.5) Total	84.9	48.3	36.6	84.9	0.0	0.0	0.0	100.0
Herd (196) Total	18405	5764	4736	10500	2741	5164	7905	57
Total/ha	131	41	34	74	19	37	56	57

Milk

	Milk(kg)	N Milk (kg)	Protein yield(kg)
Cows-Vaches (100.0) per animal	9529.7	50.2	306.2
Heifers-Génisses (83.6) per animal	0.0	0.0	0.0
Calves-Veaux (12.5) per animal	0.0	0.0	0.0
Herd	952963	5025	30623

Figure 11: Example of the output results on production and annual nitrogen excretion.

The "CSV" sub-tab

Finally, a third tab allows the user to create a file type .csv to recover all the simulation results to achieve further calculations (Figure 12 and 13). It is possible to give a name to the simulation, the default name is simulation. This name will appear in the first cell of the table to avoid losing this information when several sheets are grouped in the file.

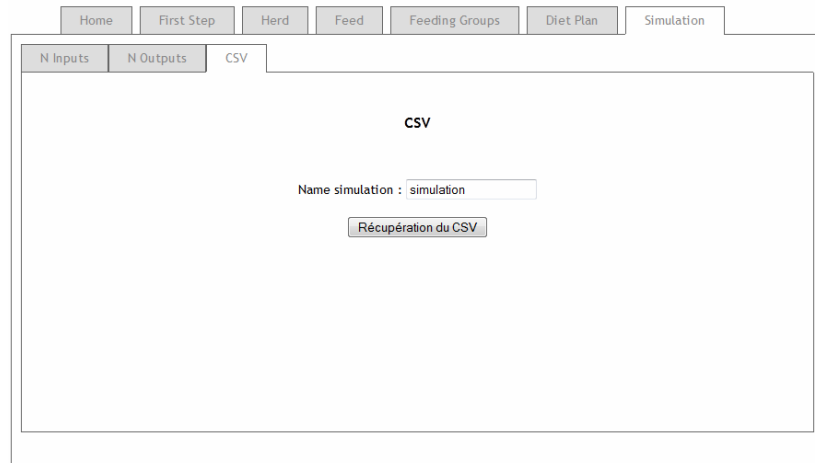


Figure 12: Screen to recover csv file with the simulation results.

simulation					
equations/lots	Cows-Vache	Heifers-GÃ©	Calves-Veau	Herd	Total/Ha
Effectif	99.9991678	83.575867	12.5267091	196.101744	
FreshGrass MS	2163.28646	1804.34811	0	367126.803	
MilkP-LaitP MS	0	0	219.000009	2743.3494	
MaizeS-EMais MS	3818.28915	387.757706	109.500004	415604.598	
Straw-Paille MS	0	310.206169	0	25925.7495	
Barley-Orge MS	835.182703	0	219.000009	86260.9246	
Soyabean M MS	801.227019	77.5515423	0	86603.4725	
FreshGrass N	61.6485935	53.2428695	0	10614.627	
MilkP-LaitP N	0	0	8.51472034	106.661425	
MaizeS-EMais N	42.1539122	4.28084507	1.20888005	4588.27476	
Straw-Paille N	0	1.73715455	0	145.184197	
Barley-Orge N	15.500991	0	4.06464016	1601.00276	
Soyabean MN	66.1493027	6.40265533	0	7149.98269	
Total Diet MS(input)	7617.98533	2579.86352	547.500022	10745.3489	
Total Diet N(input)	185.452799	65.6635244	13.7882405	264.904564	
CP	152.150463	159.07703	157.4	153.704385	
Total DM intake	761792.193	215614.331	6858.37349	984264.897	
Total N intake	18545.1256	5487.88599	172.721278	24205.7329	
Total DM produced	681670.158	209132.893	4115.02409	894918.076	
Total N produced	11930.2504	4952.77851	66.0598535	16949.0887	
Total DM imported	80122.0351	6481.43739	2743.3494	89346.8219	
Total N imported	6614.87522	535.107471	106.661425	7256.64411	
Self sufficiency(dm)	89.482429	96.9939673	60	90.9224821	
Self sufficiency(n)	64.3309225	90.2492969	38.2465057	70.0209692	
N Milk	50.2499994	0	0	5024.95813	35.6380009
N Meat	0	6.48288273	6.38451697	621.789531	4.40985483
N Feeces	68.7496931	18.9286342	3.85440015	8505.17207	60.3203693
N Urine	64.688116	40.620766	2.92191156	9900.27545	70.2147195
Total Diet N (output)	185.452799	65.6635244	13.7882405	24052.1952	
N Efficiency	27.0958431	9.87288267	46.304073	23.4770574	
totalExcretion	13343.6699	4976.89275	84.8848854	18405.4475	130.535089
Controllable feeces	5280.94525	434.85417	48.2829494	5764.08236	40.8800168
Controllable urine	4270.45246	428.844202	36.601936	4735.8986	33.5879333
Controllable total	9551.39771	863.698372	84.8848854	10499.981	74.4679501
Uncontrollable feeces	1593.96686	1147.12284	0	2741.0897	19.4403525
Uncontrollable urine	2198.30531	2966.07154	0	5164.37685	36.6267861
Uncontrollable total	3792.27217	4113.19438	0	7905.46655	56.0671386
% Controllable	71.5799911	17.3541688	100	57.0482242	57.0482242
MilkProduction	9529.70643	0	0	952962.713	
NinMilkProduced	50.2499994	0	0	5024.95813	
MilkProteinContent	306.232047	0	0	30622.9498	

Figure 13: Example of .csv file generated by CowNex as a simulation output. Each column represents data for each feeding group, the last two columns concerning the whole herd.

Conclusion

CowNex is a tool to estimate the annual consumption of feeds and protein and to calculate nitrogen excretion of dairy herds according to its characteristics and feeding management. This tool restrains some possibilities to remain easy to use. Some models are undoubtedly still improvable and some predictions may seem wrong. Well used, however, it elicits the comparison of different feeding practices and dairy herd management strategies. It offers the capacity to calculate simple indicators, to assess protein self-sufficiency and efficiency of nitrogen use. Finally, it is important to note that this tool is at herd level, not at the farm scale. It does not take into account all the mineral fertilization and cropping systems. Also, nitrogen excretion does not mean pollution, and additional calculations are needed to assess the impact on environment. However, this tool provides data on nitrogen efficiency and excretion sensitive to practices, which can be very useful for calculating further emissions to the environment.

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